CTSW-RT-00-039

SAMPLING AND ANALYSIS PLAN

CALTRANS TAHOE BASIN STORMWATER MONITORING PROGRAM

Contract 43A0036 Task Order 2

Prepared for:

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
SACRAMENTO, CALIFORNIA

DECEMBER 2000

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Contents

1.0 Project Overview

The goals of the Tahoe Basin Stormwater Monitoring Program are to:

1. Characterize stormwater runoff quality from Caltrans highway facilities located within the Tahoe Basin, including the major factors controlling the quality.

2. Characterize precipitation water quality to preliminarily evaluate the relative contributions of precipitation to observed constituent concentrations in Tahoe area highway stormwater runoff.

3. Characterize sediment quality and size.

The first year of the Study will focus on basic data gathering and on the development and testing of methods for high elevation monitoring. The objectives of the first year of this study are:

Runoff Water Quality

1. Collect data to preliminarily characterize runoff from urban and rural highways, based on the following assumptions:

   - There are two distinct types of roadway and right-of-way conditions in the basin: urban and rural.

   - Rural roadway segments have lower average daily traffic (ADT) volumes than urban segments.

2. Collect data to preliminarily characterize highway runoff during snow management operations at both lake-level and mountain pass elevations, based on the assumption:

   - Snow management operates under two modes: high elevation and lake-level elevations

3. Collect data to preliminarily characterize seasonal differences in highway runoff, based on the assumption:

   - There are three seasons: summer thunder storms, winter/spring snow melt, and transitional with snow/rain mix (fall and spring)

Precipitation Water Quality

1. Collect data to preliminarily characterize precipitation water quality, including:

   - Evaluate the variability of rainwater quality in the southern Tahoe Basin.

   - Provide preliminary data to evaluate the relative contributions of precipitation to observed constituent concentrations in Tahoe area highway runoff.

Sediment Size Distribution and Quality

1. Collect data to preliminarily identify and characterize sediment and other pollutants of concern from highway runoff, including:

   - Provide preliminary sediment characteristics
   - Determine whether storm water sediments collected by current sampling methods provide representative samples of the total sediment loading
   - Apply the first year data to refine study objectives and methods for widespread sediment sampling and testing methods.

2.0 Scope of This Plan

This Sampling and Analysis Plan (SAP) describes the monitoring of Caltrans highway stormwater runoff quality, precipitation water quality, and sediment distribution size and quality in the Tahoe Basin.

2.1 Runoff Water Quality

Monitoring of highway runoff will be conducted at three monitoring stations during summer thunderstorm precipitation events, fall/spring precipitation events, and snow melt events.

2.2 Precipitation Water Quality

Precipitation water quality samples will be collected at each of the three highway runoff monitoring stations during runoff-monitoring events, conditions permitting. Samples of "wet deposition" (rainfall and/or snowfall) only will be collected. Precautions will be taken to minimize collection of any dry deposition or "dryfall".

2.3 Sediment Size Distribution and Quality

Sediment samples will be collected at two runoff-monitoring stations in the Tahoe Basin, along with a third station located in the Central Valley near Sacramento. Up to six events will be monitored during the 2000-2001 wet season (through May 18, 2001). Since this SAP involves development of new sampling approaches, several sampling methods will be pilot- tested, assessed and refined as necessary during the monitoring period. Two proposed monitoring approaches are described in Section 12. Refinements to the monitoring methods will be communicated to Caltrans.

3.0 Project Organization and Responsibilities

This project will be conducted under the direction of Caltrans Headquarters. Camp Dresser & McKee (CDM) will manage the project from their Sacramento Office.

Monitoring station preparation and equipment installation and equipment maintenance will be conducted by CDM. A Tahoe-based field team will conduct sample collection and other field data acquisition work. CalScience Environmental Laboratories of Garden Grove will conduct sample equipment cleaning and analyses of water samples.

CDM will conduct the analysis of the sediment samples from their sediment laboratory in Denver, Colorado.

4.0 Monitoring Locations

Based on the study objectives, three highway runoff categories were selected to represent roadways in the Tahoe Basin. These categories include:

- Rural (low ADT) at lake-level elevation,
- Urban (high ADT) at lake-level elevation, and
- Rural (low ADT) at high elevation (mountain pass)

Representative monitoring locations have been selected for each of the three Caltrans roadway categories. Locations of the three selected monitoring sites are presented in Figure 4-1 and described below.

4.1 Highway 50 Near the Tahoe Airport (rural lake-level elevation)

This station (ID # 5, 50E Tahoe Airport – El Dorado County – District. 3) is located in South Lake Tahoe. The site is under the jurisdiction of Caltrans District 3 and Lahontan Regional Water Quality Control Board. The monitoring station is located within the right-of-way of the eastbound lane of State Highway 50, just south of H Street (post mile 74.27), near the Tahoe Airport.

Highway 50 is a two-lane road at this point. Only the eastbound lane drains to the curb along the eastbound lane where the station is located. Runoff from the highway flows along an asphalt curb and gutter into a dual-chamber sediment trap. Runoff samples are collected at the sediment trap inlet.

The drainage area is approximately 0.3 acres. Annual average daily traffic (AADT) is estimated to be 14,100. The site elevation is approximately 6,300 feet.

This station may be accessed using the parking lot directly across the highway (on the west side) from the monitoring station. Parking on the paved portion of the highway's shoulder is not recommended at this location due to the curve of the highway and high traffic speeds. However, parking on the grassy portion of the shoulder is permitted as long as on-coming traffic is notified using signs and traffic cones as defined in Caltrans traffic control specifications.

Directions: From the City of South Lake Tahoe:

1. Get onto Highway 50, heading west.
2. Drive 1.2 miles from the intersection with Highway 89.
3. Just past H Street, turn into the parking area located on the right side of the road.
4. The station is located across the road.

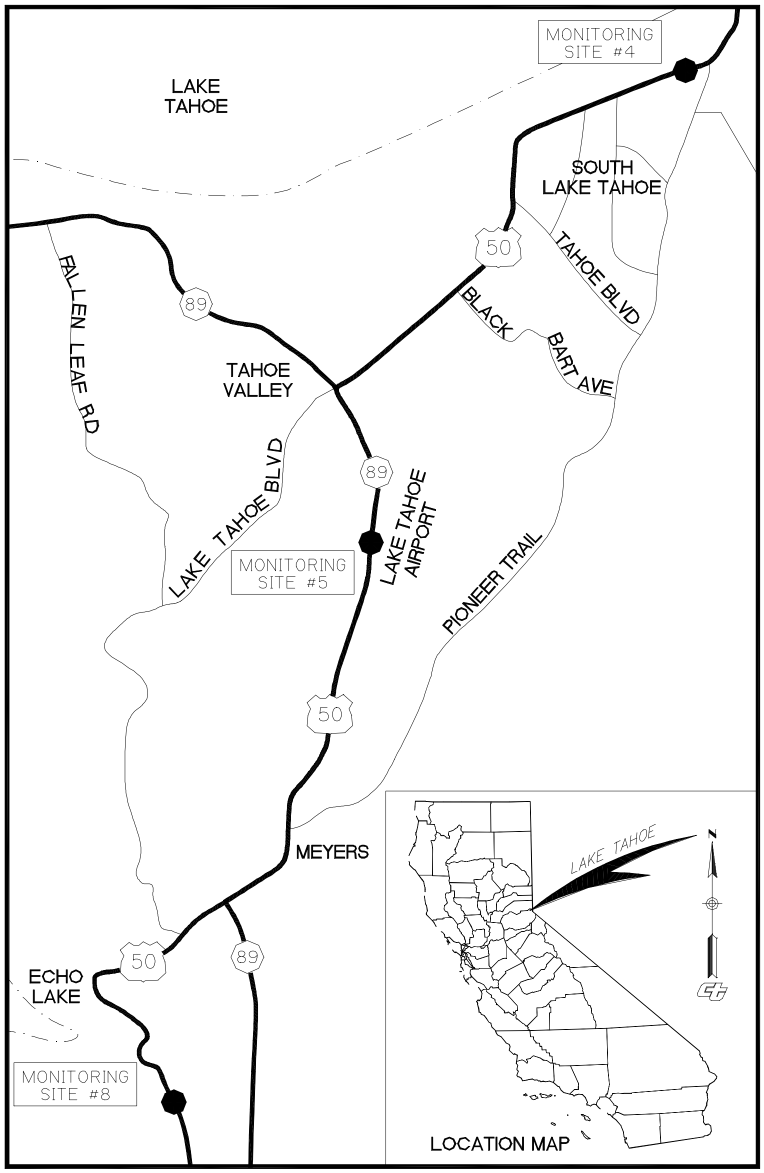


Figure 4-1. Monitoring Station Locations

4.2 Highway 50 Near Tahoe Meadows (urban lake-level elevation)

This station (ID # 4, 50W Tahoe Meadows – El Dorado County – District 3) is located in South Lake Tahoe. The site is under the jurisdiction of Caltrans District 3 and Lahontan Regional Water Quality Control Board. The monitoring station is located within the right-of-way of the westbound lane of State Highway 50, at the entrance to Tahoe Meadows residential development (post mile 79.79).

Highway 50 is a four-lane road at this point. Only the two westbound lanes drain to the curb along the westbound lane where the station is located. Runoff from the highway flows along a curb and gutter and into a drain inlet. Runoff samples are collected in an 18-inch drainpipe that collects the stormwater runoff along this portion of the highway and conveys it to the Ski Run wetland treatment facilities.

The drainage area is approximately 0.8 acres. AADT is estimated to be 37,000. The site elevation is approximately 6,250 feet.

This station may be accessed using the entrance / exit drives to Tahoe Meadows. Parking is allowed in the area between the two driveways. The station is in the area between the highway and the light pole. The monitoring equipment is housed in an underground vault.

Directions: From the City of South Lake Tahoe:

1. Get onto Highway 50, heading east.
2. Drive 4.2 miles from the intersection with Highway 89.
3. Turn into the driveway for Tahoe Meadows at post mile 79.8.

4.3 Highway 50 Near Echo Summit (rural high elevation)

This station (ID # 8, 50E Echo Summit – El Dorado County – District 3) is located between the town of Meyers and Echo Summit. The site is under the jurisdiction of Caltrans District 3 and Lahontan Regional Water Quality Control Board. The monitoring station is located within the right-of-way of the eastbound lane of State Highway 50 at post mile 67.91.

Highway 50 is a two-lane road at this point. Portions of both lanes drain to the curb along the eastbound lane where the station is located. Runoff from the highway flows along an asphalt curb and gutter into a dual-chamber sediment trap. Runoff samples are collected at the sediment trap inlet.

The drainage area is approximately 0.7 acres. AADT is estimated to be 11,600. The site elevation is approximately 7,000 feet.

Parking in the large turnout directly adjacent to the monitoring station may be used to access this station. During site visits when runoff is occurring, vehicles should be parked in a location not directly in the runoff flow stream.

Directions: From the City of South Lake Tahoe:

1. Get onto Highway 50, heading east.
2. Stay on HY 50 toward Echo Summit.
3. At post mile 67.9, turn into the large turnout located on left side of the road.
4. Meyers Grade Road and the Echo Summit pass are beyond the station.

4.4 Highway 50 Near Zinfandel Road in Rancho Cordova (Sediment monitoring only)

This station (ID # 3-07, 50E – El Dorado Co. – Dist. 3) is in the Central Valley, within the City of Rancho Cordova (refer to Figure 4-2). The site is under the jurisdiction of Caltrans District 3 and Central Valley Regional Water Control Board. The monitoring station is located within the right-of-way of the westbound lane of State Highway 50 .

Highway 50 is a eight-lane road at this point. The four westbound lanes drain to the curb along the westbound lane where the station is located. Runoff from the highway flows along an asphalt curb and gutter before being discharged into the grassy swale.

The drainage area is approximately 0.7 acres. The station is accessed from private property adjacent to the right-of-way.

Directions: From the City of Sacramento:

1. Get onto Highway 50, heading east.
2. Exit a Zinfandel Road and head north.
3. Turn right on Olson Drive.
4. Turn right into the parking lot for Zinfandel Plaza office building
5. The access gate is located at far eastern end of the parking lot.

5.0 Analytical Constituents

5.1 Runoff Water Quality

A list of analytical constituents to be analyzed in water samples obtained during each monitoring event at the highway runoff monitoring stations is presented in Table 5-1. Sample type (sample collection method), EPA analytical method, sample bottle type, target reporting limit, volume required for analysis, sample preservation, and maximum holding time are also presented in Table 5-1.

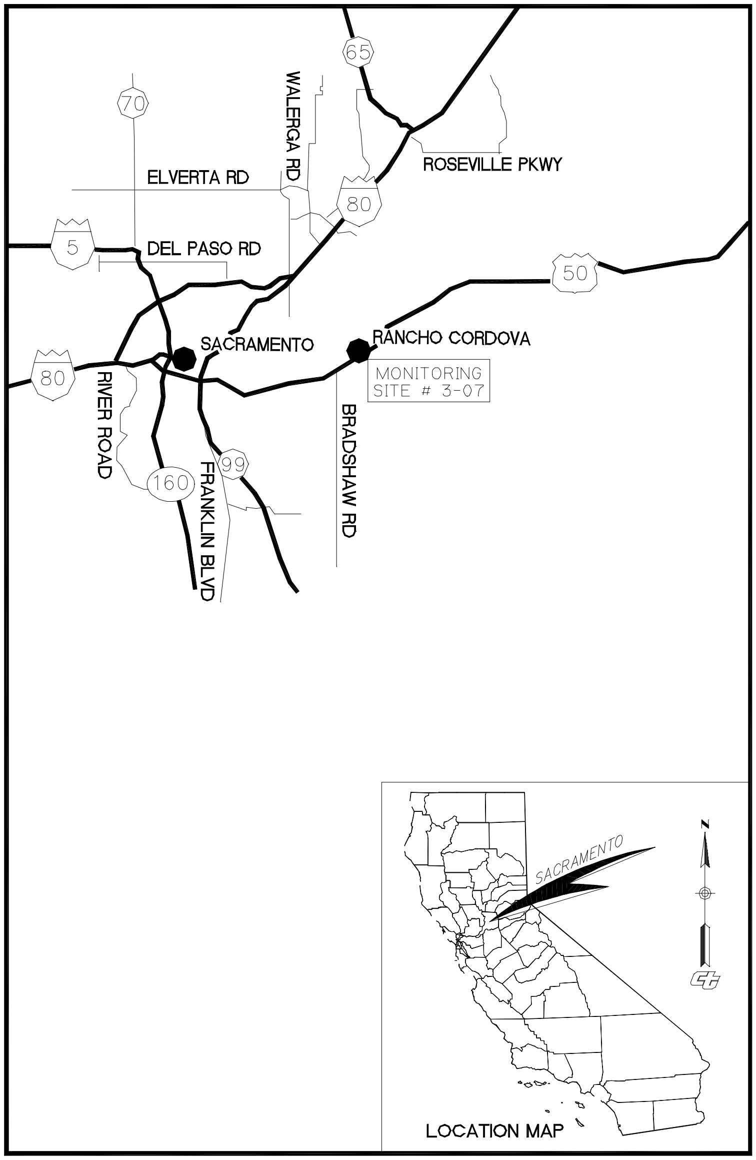


Figure 4-2. Location of Monitoring Station 3-07, HY 50 at Zinfandel Road

Table 5-1
Highway Runoff Monitoring - Constituents to be Analyzed, Sample Type, EPA Method, Bottle, Volume, Preservation, and Hold Time Requirements

Constituent	Sample Type	EPA Method	Bottle	Target Reporting Limit	Vol. (mL)	Preservation	Holding Time
Conventional							
Conductivity	Flow-based comp.	120.1	HDPE	1 mg/L	50	4°C	28 days
Hardness as Ca CO_3		130.2		2 mg/L	100	4°C	6 mo.
Temperature		NA		0.1 units	NA	None	ASAP
pH		150.1		0.1	50	none	15 min.
TDS		160.1		1 mg/L	100	4°C	7 days
TSS		160.2		1 mg/L	100	4°C	7 days
Turbidity		180.1		0.05 NTU	50	4°C	48 hrs.
TOC/DOC		415.1		1 mg/L	100	4°C; HCl or H_2SO_4; pH<2*	28 days
Chlorides		300.0		0.02 mg/L	100	4°C	28 days
Oil & grease	Grab	1664	wide-mouth glass	5 mg/L	1000	4°C; HCl or H2SO4; pH<2	28 days
Nutrients							
NO3-N	Flow-based comp.	300.0	HDPE	0.1 mg/L	100	4°C	48 hrs.
Dissolved Ortho-P		365.2		0.03 mg/L	100		48 hrs.
Total P		365.3		0.03 mg/L	100		28 days
TKN		351.3		0.1 mg/L	100		28 days
Metals (total & dissolved)							
Arsenic (As)	Flow-based comp.	206.3	HDPE	0.5 µg/L	100	4°C; HNO3; pH <2*	Filter for diss. & preserve 48 hrs. Analysis 6 mo.
Cadmium (Cd)		200.8		0.2 µg/L			
Chromium (Cr)		200.8		1 µg/L			
Copper (Cu)		200.8		1 µg/L			
Iron (Fe)		200.9		25 µg/L			
Lead (Pb)		200.8		1 µg/L			
Nickel (Pb)		200.8		2 µg/L			
Zinc (Zn)		200.8		5 µg/L			

*No preservative at time of composite sample collection; preservation at laboratory during sample splitting.

5.2 Precipitation Water Quality

The list of analytical constituents for precipitation water quality monitoring includes a subset of those constituents listed in Table 5-1 that are considered likely to be present in precipitation in measurable quantities. The list is confined to those constituents for which samples may be collected as composites, and for which collection of sufficient sample volume can be expected to permit analysis.

Limitations in sample volume are common in precipitation monitoring, and the goal will be to analyze as many of the listed constituents as is feasible for each monitoring event, given the specific precipitation amount and the actual sample volume collected. Metals and nitrate are considered the highest priority for precipitation analysis. It is assumed that most constituents will be present in the dissolved form in precipitation; it is therefore not necessary to analyze for both dissolved and total recoverable metals, for example.

Precipitation samples will be analyzed for the prioritized list of constituents shown below:

High Priority Constituents:

- Conductivity
- pH
- Nitrate
- Metals (total recoverable only):
  - Arsenic
  - Cadmium
  - Chromium
  - Copper
  - Iron
  - Lead
  - Nickel
  - Zinc

Mid-level Priority Constituents:

- Hardness
- Chloride

Additional Constituents (when sample volume is adequate):

- Phosphorous
- Orthophosphate
- TKN

This list is subject to review and revision pending evaluation of the initial monitoring results and other issues and priorities as determined by Caltrans. Refer to Table 5-1 for analytical methods, bottle volume, preservation, and holding time requirements.

5.3 Sediment Size Distribution and Quality

A list of analytical constituents to be analyzed in sediment samples obtained during each storm event at each of the monitoring locations is presented in Table 5-2. Table 5-2 also summarizes constituents, EPA analytical methods, target reporting limits, volumes required for analysis, sample preservation, and maximum hold times.

The sieve sizes to be used by the laboratory for the grain size distribution analysis using the wet sieving method are presented in Table 5-3. The sieve sizes may be modified in order to collect sufficient sediment masses of the various size fractions for chemical analyses. This may be accomplished by compositing various size fractions following sieving. Sediment sizes smaller than 20 μm will be analyzed for grain size distribution using the hydrometer method (ASTM D422) or a particle counter.

Table 5-2
Sediment Sample Laboratory Analyses

Constituent	EPA Analytical Method	Reporting Limit (mg/kg)	Required Mass/ Volume	Sample Preservation	Maximum Hold Time
Total Phosphorus	EPA Method 365.3	1	2 g	Chilled	28 days
Total Organic Carbon	EPA Method 415.1	50	2 g	Chilled	28 days
Total Nitrogen	EPA Method 351.4	1	2 g	Chilled	48 hours
Arsenic	EPA Method 6010	0.5	1 g	Chilled	6 months
Cadmium		0.5			
Chromium		0.5			
Copper		0.5			
Lead		5			
Nickel		2.5			
Zinc		0.5			
Iron		0.5			
Grain Size Distribution Analysis – Sieve Method	ASTM D422M/D4464	NA	50-100 g	NA	NA
Grain Size Distribution Analysis – Hydrometer Method	ASTM D422-63	NA	NA	NA	NA

Table 5-3
Sieve Sizes for the Grain Size Distribution Analysis

U.S. Standard Sieve Size	Mesh Opening (microns)
4	4,750
6	3,350
8	2,360
10	2,000
16	1,180
20	850
30	600
40	425
50	300
70	212
100	150
200	75
400	38
635	20

6.0 Data Quality Objectives

To provide scientifically defensible data in fulfillment of program objectives discussed in Section 1, data quality objectives are used to establish acceptable measures of data quality for monitoring data. The data quality objectives for this project include specifications for sampling and analytical procedures, and performance criteria for laboratory analytical work. Analytical methods, target reporting limits, sample preservation requirements, and maximum allowable holding times are presented in Tables 5-1 and 5-2. Performance control limit criteria for precision and accuracy are presented in Tables 6-1 and 6-2. Table 6-1 lists the control limits for water samples and Table 6-2 lists the control limits for sediment samples. For guidance on application of performance acceptance criteria and QA / QC data evaluation refer to Section 13 of Guidance Manual: Stormwater Monitoring Protocols, Caltrans, May 2000 (CTSW-RT-00-005).

Table 6-1
Control Limits for Precision and Accuracy for Water Samples

Constituent	EPA Method	Maximum Allowable RPD	Recovery Lower Limit	Recovery Upper Limit
Conventional				
Conductivity	120.1	20%	NA	NA
Hardness as Ca CO_3	130.2	20%	80%	120%
pH	150.1	20%	NA	NA
TDS	160.1	20%	80%	120%
TSS	160.2	20%	80%	120%
Turbidity	180.1	20%	NA	NA
TOC/DOC	415.1	15%	85%	115%
Chlorides	300.0	20%	80%	120%
Oil & grease	1664	18%	79%	114%
Nutrients				
NO3-N	300.0	20%	80%	120%
Dissolved Ortho-P	365.2	20%	80%	120%
Total P	365.3	20%	80%	120%
TKN	351.3	20%	80%	120%
Metals (total & dissolved)				
Arsenic (As)	206.3	20%	75%	125%
Cadmium (Cd)	200.8	20%	75%	125%
Chromium (Cr)	200.8	20%	75%	125%
Copper (Cu)	200.8	20%	75%	125%
Iron (Fe)	200.9	20%	75%	125%
Lead (Pb)	200.8	20%	75%	125%
Nickel (Pb)	200.8	20%	75%	125%
Zinc (Zn)	200.8	20%	75%	125%

Notes: RPD = relative percent difference between duplicate analyses.

Recovery, lower and upper limits refer to analysis of spiked samples.

Table 6-2
Control Limits for Precision and Accuracy for Sediment Samples

Constituent	EPA Method	Maximum Allowable RPD	Recovery Lower Limit	Recovery Upper Limit
Conventional				
TOC	415.1	15%	85%	115%
Nutrients				
Total P	365.3	20%	80%	120%
Total N	351.4	20%	80%	120%
Metals				
Arsenic (As)	6010	20%	75%	125%
Cadmium (Cd)	6010	20%	75%	125%
Chromium (Cr)	6010	20%	75%	125%
Copper (Cu)	6010	20%	75%	125%
Iron (Fe)	6010	20%	75%	125%
Lead (Pb)	6010	20%	75%	125%
Nickel (Pb)	6010	20%	75%	125%
Zinc (Zn)	6010	20%	75%	125%

Notes: RPD = relative percent difference between duplicate analyses.

Recovery, lower and upper limits refer to analysis of spiked samples.

7.0 Equipment

Each of the three runoff monitoring stations is equipped with an American Sigma 900 peristaltic pump sampler, an American Sigma 950 flow meter and sensor, an American Sigma electronic tipping bucket rain gauge, a 12 Volt power source, and precipitation monitoring equipment. Monitoring equipment is housed in either a locked box enclosure or underground vault at each of the monitoring stations. The monitoring station components are described briefly below.

7.1 Automatic Sampler

The American Sigma 900 automatic sampler consists of a Teflon coated stainless steel intake strainer, Teflon intake tubing, flexible pump tubing, a peristaltic pump, a composite sample bottle, and a controller. The sampler will be programmed to collect flow-based composite samples. The intake strainer is securely fastened at a location in the runoff flow stream. The Teflon intake tubing is securely fastened to the intake strainer, then housed in protective conduit to the point where the tubing enters the monitoring equipment steel box enclosure. The Teflon intake tubing is attached to the flexible pump tubing at the sampler. The flexible pump tubing runs through the sampler peristaltic pump into the composite sample bottle.

Since the samplers will be configured to collect flow weighted samples, a signal will be sent from the flow meter to the sampler, and a sample aliquot collected, after a programmed volume of flow has passed the flow monitoring point. This programmed volume between sample aliquot collection is established based on forecasted rainfall totals and estimated runoff volumes.

7.2 Flow Meter

American Sigma 950 flow meters will be utilized at each of the three monitoring stations. The flow meter will be programmed to initiate water quality sampling based on user-selected conditions; generally the exceedance of some predetermined flow volume at the monitoring location. At the two stations with dual chamber sediment traps, a weir has been installed at the outlet of the second sediment trap. The flow meter will measure the depth of flow over the weir. The flow meter converts depth measurements to flow volumes based on the configuration of the weir. At the third station, an area-velocity flow meter has been installed in an 18-inch diameter drainpipe. The flow meter calculates flow volumes from depth and velocity measurements.

7.3 Rain Gauge

American Sigma electronic tipping bucket rain gauges will be used to measure and record precipitation amounts at each of the monitoring stations. The rain gauge is mounted at the top of a vertical steel pole, with a cable running inside the pole into the steel box enclosure. The gauge records precipitation in 0.01-inch increments. Rainfall is funneled into a tipping bucket mechanism that tips when a volume equivalent to 0.01 inches of precipitation has accumulated. For each bucket tip, a signal is sent to the data logger to record 0.01 inches of precipitation.

7.4 Precipitation Quality Sampler

Precipitation samples will be collected in a high-density polyethylene (HDPE) liner that slips into a 3.5-gallon capacity plastic bucket. The bucket with liner will be pole-mounted in an area having a clear opening to the atmosphere, without vertical obstruction. The pole will extend approximately eight feet above grade. A plastic or wire basket will be affixed to a plate on the top of the pole, and used to hold the bucket. The bucket handle will be attached on to the basket to secure the bucket during use.

At the Echo Summit and Tahoe Airport sites, the mounting pole will be attached to the runoff monitoring enclosure, in the same manner as the rain gage pole. At the Tahoe Meadows site the mounting pole will be freestanding, and will be sunk in concrete in a hole in the ground.

At one site, an automated wet deposition collector (the ADS WDO 2000 Atmospheric Deposition Sampler by N-CON Systems Co., Inc.) will be installed, to provide comparative data for the manually-installed sample collection bucket.

7.5 Sediment Sampling Equipment

Two sediment-sampling approaches are proposed for sampling Caltrans drainage facilities – a water volume approach and a filter approach. Sampling equipment for these two approaches is described briefly below. A thorough description of sediment sampling equipment is located in Section 10.

7.5.1 Sediment Sampling - Water Volume Approach

Collection of sediment samples using the water volume sampling approach is conducted using two techniques. The first is manually, using a bucket to collect runoff sample aliquots on a flow increment. The second technique uses the Amercian Sigma 900 autosampler to collected sample aliquots on a flow-paced basis. Sample aliquots from either method are filtered on site through a 0.45 um filter. The individual filters with the sediment are sent to the laboratory for compositing and analyses for particle size and quality.

7.5.2 Sediment Sampling Equipment – Filter Approach

This collection procedure utilizes a passive filtration system to collect the majority of the sediment as the stormwater passes through the sand traps and into the natural channel downstream. Filters are placed in the existing sediment traps to collect the sediment that settles out and a filter box is placed at the discharge of the sand traps to collect sediment that passes through the traps.

8.0 Health and Safety

Health and safety procedures that have been established for the Caltrans Tahoe Basin Stormwater Monitoring Project must be followed at all times. These procedures are presented in the document, *Caltrans Tahoe Basin Stormwater Monitoring Program Health and Safety Plan*. A copy of the plan is located in Appendix A. Each field team member will receive a copy to review prior to the start of the monitoring project. A copy must always accompany each crew out in the field.

Several general procedures that must be followed at all times include:

- All field personnel must wear hard hats, traffic vests, and steel-toed boots when working outside the vehicle.
- Traffic control must be set up before conducting any work in the Caltrans right-of-way where personnel will be exposed to traffic. Standard traffic control measures include parking vehicles to shield personnel from traffic and using hazard lights.
- No field personnel will enter a sediment trap, manhole or storm pipe without submitting a confined-space entry permit with CDM. Confined space entry procedures are included in the Health and Safety Plan.
- Housing lids and sampler trays containing full bottles can be very heavy. Personnel must be careful when lifting to avoid injury and / or spilling the samples (i.e., keep back straight and lift with your legs).
- Clean nitrile gloves will be worn by all field crew members when working with sampler bottles (empty and filled) and during grab sampling.
- All electronic equipment should be kept as dry as possible.

- The field leader for each field crew will be responsible for answering the phone and making calls. Therefore, the assistant should be responsible for all of the driving.

9.0 Monitoring Preparations and Logistics

Sample bottle ordering, bottle labels, runoff monitoring tubing installation, field equipment maintenance, monitoring event selection criteria, weather tracking, notification procedures, and bottle labeling procedures are presented in this section.

9.1 Bottle and Blank Water Order

Prior to the first targeted storm and immediately after each monitored storm event, bottles for the next event must be ordered from the laboratory. Adequate composite and grab sample bottles will be ordered for each of the monitoring stations, plus bottles for quality control samples. Blank water will be ordered for those constituents that require field blank collection.

Prior to each targeted storm at least five of the 10 liter polyethylene composite sample bottles and lids shall be cleaned by the laboratory according to the methods specified in Appendix B.

9.2 Bottle Labels

All grab and composite sample bottles should be pre-labeled to the extent possible before each stormwater-monitoring event. Pre-labeling sample bottles simplifies field activities, leaving only date, time, sample number, and sampling personnel names to be filled out in the field. Basic bottle labels are available pre-printed with space to pre-label by hand writing or typing. Custom bottle labels may be produced using blank labels and labeling software. The bottle label should include the following information, with other items as appropriate:

Project Name ________________________
Station Name_________________________
Sample Code_________________________(see below for sample code development)
Date ____________ Time_______________
Sample __ of __. Type _(grab/composite)__
Collected by __________________________
Preservative ________ Analysis __________

Each sample bottle label shall include a sample identification code as shown below.

SSRYYMMDDHHmmTT

Where:

SS	=	station number (04, 05, or 08)
R	=	runoff (P = precipitation, S = Sediment)
YY	=	last two digits of the year (00)
MM	=	month (01-12)
DD	=	day (01-31)

HH	=	hour of the sample (00-23)		
mm	=	minute of the sample collection (00-59)		
TT	=	type of sample		
		R#	=	runoff sample
		EB#	=	equipment blank
		FS#	=	field split
		#	=	bottle number

Note: Day, hour, and minute represent the day and time when the rain ended.

All sample bottles should be labeled on the bottle rather than the cap to identify the sample for laboratory analysis. Sample labels should include type of sample (precipitation samples are considered composite samples), type of QC sample (i.e. field splits), sampler's name, date, time, and location. For a runoff sample collected at Site 8 collected on December 8, 2000, the sample number will be as follows given the rainfall ended at 4:15 PM:

08R0012081615R1

Bottles should be labeled in a dry environment prior to field crew mobilization. Attempting to apply labels to sample bottles after filling may cause problems, as labels usually do not adhere to wet bottles. The labels should be applied to the bottles rather than to the caps.

9.3 Intake and Suction Tubing Installation

Clean intake and pump tubing should be installed using “clean techniques”, so as not to contaminate the tubing. The tubing should remain double bagged until the time of installation. The tubing ends should be covered with clean latex material to keep the tubing clean during installation, which involves feeding the tubing through protective conduit. During installation, the intake and pump tubing should only be handled wearing clean nitrile gloves. During installation, the tubing ends should not touch any item not known to be clean. It is important to avoid kinking of the intake tubing during installation, as this will hinder sample collection.

Once the tubing has been installed, the laboratory-cleaned Teflon-coated stainless steel intake strainer should be installed using “clean techniques”. During installation, the strainer should only be handled while wearing clean nitrile gloves. The strainer should be attached to the end of the intake tubing and secured at the designated sampling location. All hardware in the immediate area of the intake strainer (hardware used to secure the suction tubing and intake strainer) must be stainless steel, polyethylene, or Teflon to minimize the possibility of sample contamination.

9.4 Field Equipment Maintenance

Prior to the first targeted storm and immediately after each of the subsequent sampling events, field personnel will inventory field equipment (see Figure 9-1 for field equipment checklist). Field equipment should be kept in one location, which is used as a staging area to simplify field crew mobilization.

Field personnel shall also perform field maintenance and testing of equipment to ensure proper operation. At a minimum, the frequency and nature of equipment maintenance shall be consistent with the manufacturer's recommendations. It is anticipated that there will be a period each year (May through July) when the equipment will not be operational. Equipment adversely affected by long non-operational periods will be removed, stored, and reinstalled prior to the commencement of the next sampling period. Records will be kept of all equipment maintenance.

Standard equipment preparation procedures will be conducted prior to each target storm that is monitored for water quality, precipitation quality and sediment. For the water quality monitoring equipment, the autosampler, flow meter and rain gage are all inspected. Tubing, clamps or cable ties, electrical connections, battery strength, intake strainer, flow probe, and programming are all checked. For the precipitation monitoring, mounting poles and holders are inspected and cleared of any debris. For the sediment monitoring, the sediment traps and filter boxes must be prepped before installing the filter fabrics. Large debris that may tear the fabric will need to be removed.

9.5 Composite Bottle Installation

Prior to each monitoring event, laboratory-cleaned pre-labeled composite sample bottles will be installed into both the autosampler and precipitation station using "clean techniques". The composite bottles must be sealed in a plastic bag until the time of installation. The lids must be kept individually double-bagged when not in use. During installation, the bottles and lids should be handled only while wearing clean nitrile gloves, and the lids should not touch any item not known to be clean. At no time should any object or material (even clean, gloved hands) contact the inner surface of a composite bottle or lid.

9.6 Sediment Filter Installation

Prior to each monitoring event, cleaned filters and filter fabric will be installed into both into either the sediment traps or filter box using "clean techniques". The filters will be sealed in a plastic bag until the time of installation. During installation, the filters and filter fabric should be handled only while wearing clean nitrile gloves..

Storm Kit Equipment List

- ☐ First aid kit
- ☐ Keys to enclosure locks
- ☐ Flashlights (2) - hand held and lantern
- ☐ Maps
- ☐ Large flat screwdriver
- ☐ Small flat screwdriver
- ☐ Extra batteries
- ☐ Writing pens (2),
- ☐ Diagonal cutters water
- ☐ Electrical tape
- ☐ Cable ties (assorted sizes)
- ☐ Utility knife vests
- ☐ Ziplock baggies (assorted sizes)
- ☐ Gloves - nitrile
- ☐ Duct tape

Storm Mobilization Equipment List

- ☐ Storm kit
- ☐ Log books/log sheets
- ☐ Paper towels
- ☐ Autosampler bottles
- ☐ Sediment filters and filter fabric
- ☐ Precipitation sample buckets and liners
- ☐ Bottle labels
- ☐ Coolers and ice
- ☐ Laboratory-provided blank water
- ☐ Cellular phone
- ☐ Personal rain gear
- ☐ Hardhats and orange safety
- ☐ Traffic cones/signs
- ☐ Health and Safety Plan

Figure 9-1. Field Equipment Checklist

9.7 Storm/Event Selection Criteria

Event selection criteria for Runoff, Precipitation, and Sediment monitoring are presented below.

9.7.1 Runoff Monitoring

Selection criteria for summer thunderstorm runoff monitoring, fall/spring storm runoff monitoring, and snowmelt runoff monitoring are presented below.

Summer Thunderstorms

Summer storms that meet the following criteria will be considered for monitoring:

- Approximately 50% or higher probability of precipitation,
- Quantity of Precipitation Forecast (QPF) of 0.2" or greater, and
- At least a 24-72 hour dry period preceding precipitation.

Fall/Spring Precipitation Events

Fall/Spring storms (which may contain a mixture of rain and snow) that meet the following criteria will be considered for monitoring:

- Approximately 50% or higher probability of precipitation,
- QPF of 0.2" or greater, and
- At least a 24-72 hour dry period preceding precipitation.

Snowmelt runoff monitoring differs fundamentally from stormwater runoff monitoring in that sampling can be initiated in response to runoff flow in the absence of precipitation. Once substantial snowfall has occurred, the following criteria will be considered for monitoring:

- Adequate snow is present on the ground to generate snowmelt runoff,
- Temperatures have warmed to cause snow to melt and run off, and/or
- Salts are applied to melt the snow.

9.7.2 Precipitation Monitoring

Storms that meet the following criteria, which are the same criteria used for storm event selection for runoff monitoring, will be considered for precipitation monitoring:

- Approximately 50% or higher probability of precipitation,
- QPF of 0.2" or greater, and
- At least a 24-72 hour dry period preceding precipitation.

9.7.3 Sediment Monitoring

Storms that meet the following criteria, which are the same criteria used for storm event selection for runoff and precipitation monitoring, will be considered for sediment monitoring:

- Approximately 50% or higher probability of precipitation,
- QPF of 0.2” or greater, and
- At least a 24-72 hour dry period preceding precipitation.

9.8 Weather Tracking

When the stormwater-monitoring program is active, the monitoring task manager or field coordinator continuously tracks weather conditions and potential storms. The frequency of weather tracking increases as incoming storms are identified as candidates for stormwater monitoring.

As a candidate storm approaches, a quantity of precipitation forecast (QPF) is projected by either a contract weather forecasting service or the National Weather Service. This is the amount of precipitation (in inches) expected over the entire storm event, and is normally provided along with the expected start time and duration of the storm. This information serves two essential purposes. First, it is necessary to determine, prior to making the decision to mobilize for a storm event, whether the storm will produce adequate runoff to permit collection of a meaningful set of samples. Second, because composite samples are typically collected on a flow-weighted basis, samples must be collected at appropriate intervals so as to not under-fill or over-fill the composite bottles, based on the rainfall/runoff amounts expected during the course of the storm. When automated sampling equipment is used, the equipment must be programmed in advance with the appropriate flow-pacing rate.

If a storm event QPF is over-predicted, and the actual rainfall amount falls far short of the prediction, there may not be enough sample collected during the course of the monitoring event to conduct the specified analyses. If the QPF under-predicts the amount of rainfall actually received, then the composite bottles may need to be replaced one or more times during the event. Because it is more difficult to recover from an over-predicted QPF (inadequate sample volume), a conservatively low estimate of the expected rainfall amount is often used in programming the samplers, often equal to approximately one half of the forecast QPF.

9.9 Notification Procedures

The telephone tree (Figure 9-2) shows the lines of communication and notification responsibilities for the monitoring project. The telephone tree is used for stormwater monitoring preparation activities, communications during monitoring, and coordinating demobilization activities following a monitored event.

Caltrans Personnel

Masoud Kayhanian (UCD) (916) 278-8112 o
Kuen Tsay (HQ) (916) 653-5240 o
Sean Penders (Dist 3) (530) 741-4494 o

Task Manager

Lou Regenmorter (916) 567-9900 o
(916) 708-3755 c
(916) 567-9905 f

CalScience Laboratory

(714) 895-5495 o
(714) 894-7501 f

Steve Nowak (310) 827-6683 h
Bob Sterns (714) 335-4034 c
(949) 643-5517 h

Courier Service:

Golden State Overnight (800) 322-5555

Field Coordinator

Blake Johnson CDM
(916) 567-9900 o
(916) 204-6869 c
Tom Quasebarth CDM
(916) 567-9900 o
(916) 708-3752 c
Eric Zeigler LWA
(530) 753-6400 o

Field Crew

Brian Grey (530) 542-5445 w
(530) 577-4683 h
Beth Gross (530) 542-5560 w
(530) 542-0923 h
Larry Underwood
(775) 853-0333 w
(775) 575-2404 h
(775) 690-9339 c

Monitoring Equipment:

American Sigma
24 hour help line (800) 653-1230
Oratech (local sales rep.)
Rob Larsen (415) 467-9455 o
(415) 467-4319 f

Forecasters:

Weather Watch (619) 223-8163

National Weather Service (916) 979-3051

Emergency: **911**

Hospital
Barton Memorial Hospital (530) 541-3420

KEY
o = office
c = cellular
f = fax
h = home
p = pager
v = voice mail

Figure 9-2. Telephone Tree

The telephone tree shows pertinent telephone numbers for each person involved in the project, including laboratory personnel numbers for the purpose of after-hours sample delivery. Emergency telephone numbers are also listed, including the number for the hospital nearest the monitoring stations.

10.0 Runoff Water Quality Sample Collection

Clean sampling techniques, field crew mobilization, pre-event set-up activities, event monitoring activities, post-event activities, and special considerations for cold weather and snowmelt monitoring are presented below.

10.1 Clean Sampling Techniques

"Clean sampling" techniques are required to provide for the collection of water samples in a way that neither contaminates, loses, or changes the chemical form of the analytes of interest. Samples are collected using rigorous protocols, based on EPA Method 1669, as summarized below:

- Samples are collected only into rigorously pre-cleaned sample bottles.
- At least two persons, wearing clean nitrile gloves at all times, are required on a sampling crew.
- One person ("dirty hands") touches and opens only the outer bag of all double bagged items (such as sample bottles, tubing, strainers and lids), avoiding touching the inside of the bag.
- The other person ("clean hands") reaches into the outer bag, opens the inner bag, and removes the clean item.
- When a clean item must be re-bagged (such as a composite bottle lid), it is done in the opposite order from which it was removed.
- Clean nitrile gloves are changed whenever something not known to be clean has been touched.
- In order to reduce potential contamination, sample collection personnel will adhere to the following rules while collecting stormwater samples:

  (1) No smoking!

  (2) Never sample near a running vehicle. Do not park vehicles in immediate sample collection area (even non-running vehicles).

  (3) Avoid allowing rainwater to drip from rain gear into sample bottles.

  (4) Do not eat or drink during sample collection.

  (5) Do not breath, sneeze, or cough in the direction of an open sample bottle.

For this program, clean techniques must be employed whenever handling the composite bottles, bottle lids, suction tubing, or intake strainers.

10.2 Field Crew Mobilization

When a candidate storm is approaching, or when a potential snowmelt event may occur, the monitoring task manager will alert the field crew and analytical laboratory. Field crews will be given notice to mobilize when precipitation or snowmelt has begun.

When first alerted, field crewmembers should check monitoring equipment and supplies to ensure they are ready to conduct monitoring. Once given the go-ahead by the monitoring task manager, the field crew members will obtain adequate ice for each station, including grab samples, and travel to each station to conduct final preparations for monitoring.

Site Check

- Set-up traffic safety controls. Upon arriving at each station, traffic safety controls must be set-up as required.

- Access equipment. Access to the monitoring equipment is gained by unlocking the padlocks to the lid of the enclosure, and lifting the lid until both hinges lock. Be careful to check for spiders and wasps in the padlock case and inside the housing.

- Perform all the inspections listed in both the Sampler Inspection and Set-Up sections of the *Station Visit Checklist for Set-Up/Bottle Replacement/Shut-Down Form* (Appendix C).

10.3 Pre-Event Set-Up

The following are set-up activities that should be conducted prior to each runoff monitoring event.

10.3.1 Check Autosampler Set-up

1. Replace the sampler battery. Replace the existing battery with a freshly charged one at battery operated stations.

2. Inspect tubing and connections.

   - Remove sampler control lid by releasing the upper row of latches (3).

   - Perform the following checks:

     1) Intake tubing for kinks and twists (remove or straighten if found).

     2) Clamps for tightness and conditions (tighten if loose, replace if broken or missing).

     3) All electrical connections for tightness.

     4) Pump tubing for cracks and excessive wear / tear (replace if found).

3. Place clean sampler bottle in the base of the sampler.

   - Release the bottom row of latches (3) and lift off the control section using the handles on the side of the sampler.
   - Pump tubing must be connected and not kinked.
   - Place a clean composite bottle with lid in the base.
   - Using clean techniques, remove the bottle lid and store in a clean Ziploc bag (this lid will be reused when retrieving full composite bottle), and replace with clean tubing-hole lid.
   - Using clean techniques, remove pump tubing end cover and insert tubing into the composite bottle.
   - Fill the base with crushed ice (approximately one 5-pound bag).
   - Place the control section back onto the base and shut each latch.

4. Review sampler programming.

   - Open the site notebook to the page documenting the Sampler Set-up and Programming.
   - Compare the entries displayed by the sampler to those entries highlighted in the set-up document.

     1) Turn on the sampler by pressing the ON key. After a moment, the display reads either "READY TO START", "PROGRAM HALTED", or "PROGRAM COMPLETE." Press the * key, located next to the display window.
     2) Press the NO key to the question, "Alter Parameters?"
     3) The sampler now automatically scrolls through selected parameters.
     4) Upon completion of the review, the display should again read “READY TO START”, “PROGRAM HALTED”, or “PROGRAM COMPLETE.”

   - Notify the Field Coordinator of any differences between the sampler's program and set-up document; re-program as instructed by the Field Coordinator.
   - Press the START PROGRAM key. The display should read "PROGRAM RUNNING," if not the sampler must be re-programmed based on the entries in the set-up document.

5. Match the sampler's clock to the flow meter's clock.

   - Wake up the flow meter by pressing the button on upper right side of the case.

- The current time and date are displayed on the top bar of any display screen.

- Press the TIME READ key on the sampler to display the current time and date; they will be displayed for several seconds.

- The sampler's time and date should match the flow meter's time to the minute.

- If there is a difference between the two times, change the sampler's time to match the flow meter's unless the flow meter is obviously wrong.

- Change the sampler's time and / or date.

  1) Press the TIME SET key.

  2) The time and date will be displayed with the hour flashing, change the hour by pressing the appropriate numerical key(s) and then pressing the YES / ENTER key.

  3) Minutes will now be flashing and can be changed by entering the correct numeric values and pressing the YES / ENTER key.

  4) Continuing this same procedure for setting time and date, pressing the YES / ENTER key to skip over correct entries.

  5) After the correct year is entered, the display will first read "SYNCHRONIZE TIME" and then "- ENTER- AT TIME".

  6) Press the YES / ENTER key to start the clock; the display will then move through "CLOCK IS NOW SET", the new time and date, and finally stop at the program status.

6. Replace the control lid. Place the lid back over the control section and close the three latches, being careful not to pinch the sampler tubing.

10.3.2 Check Flow Meter Set-up

1. Wake the flow meter.

   A. Press the button on the upper right hand side of the flow meter to wake the meter and illuminate the screen.

   B. If the STATUS SCREEN is not shown (check the upper right corner), this screen will need to be accessed.

      - Open the clear plastic case lid by unlatching the two latches on the right side.

      - Press the MAIN MENU key

      - Press the "STATUS" option

- the STATUS SCREEN should now be displayed

2. Record flow and rainfall volumes. Read the total flow in cubic feet (cf) and the total rainfall (in) from the screen and record these values on the Set-Up section of the *Station Visit Checklist for Set-Up/Bottle Replacement/Shut-Down Form* at the designated space.

3. Review flow meter programming, if directed by the Field Coordinator.

   A. Open the site notebook to the page documenting the Flow Meter Set-up and Programming.

   B. From the Main Menu screen, select the "SETUP" option.

   C. From the Setup screen, select the "REVIEW ALL ITEMS" option.

   D. The current programming will be displayed. To view all entries, use the option to scroll through the entire listing.

   E. Compare the programmed items to the entries documented on the *Flow Meter Set-up and Programming Form* located in the station notebook. If they do not match, call the Field Coordinator for direction.

   F. Press the Main Menu key to return to the main menu.

4. Program the trigger volume, if directed by the Field Coordinator.

   A. Press the RUN / STOP key to halt the program. The word "HALTED" should be flashing in the lower left corner.

   B. Press Main Menu key to access the Main Menu screen.

   C. Select the "SETUP" option.

   D. Select the "MODIFY SELECTED ITEMS" option.

   E. Scroll down the listing until "SAMPLER PACING" is highlighted, press the "SELECT" option.

   F. Accept "ENABLE" by pressing the "ACCEPT" option.

   G. Clear the existing entry, by selecting the "CLEAR ENTRY" option.

   H. Key in a new value per the Field Coordinator, and press the key for the "ACCEPT" option.

   I. Return to the main menu screen by pressing the "RETURN" option.

J. Press the RUN / STOP key, then select the "RESUME" option. The program will restart, which is confirmed by the word "RUNNING" displayed in the lower left corner.

5. Shut the case lid and close the latches.

10.4 Event Monitoring Activities

Stormwater runoff monitoring event activities are described below.

10.4.1 Composite Sample Collection

After all of the pre-event set-up steps have been taken, flow weighted composite sample collection will begin automatically once runoff begins, and will continue as long as significant runoff flow is present.

10.4.2 Grab Sample Collection

Grab samples for oil & grease will be taken at each monitoring site once per season. It is desired that grab samples be collected during storm event peak flow. However, due to the difficulty in predicting the time of peak flow, grab sampling during peak flow may not be possible. Therefore, to the greatest extent possible, grab samples will be collected at the approximate mid-point of the discharge period.

Oil & grease grab samples will be collected by directly submerging the sample bottle into the flow stream, allowing to fill, capping, and placing on ice.

10.5 Post-Event Activities

- Perform all tasks listed in the Shut-Down Checks section of the *Station Visit Checklist for Set-Up/Bottle Replacement/Shut-Down Form*.

- Record the sampling times on the Field Data Log (Appendix C).

- Fill in the top portion of the form, making sure to indicate the "composite sample replacement" number (especially important if bottles have been replaced over the course of the event at a particular site).

- Turn the page over and fill in the station ID number, time, and date on the top three lines.

- Record the individual sampling data in the table.

  1) Press the TIME READ key on the sampler for three (3) seconds, the time of the first sample should be displayed

  2) Record date, time, and any notes on the "Trigger #1" line of the Sample Identification Form

  3) Press the ENTER key to move to the next sample time and record information on line #2 of the table

4) Continue pressing the ENTER key and recording information on subsequent lines until "PROGRAM HALTED" is displayed

Record flow and rainfall volumes.

- Press the button on the upper right hand side of the flow meter to wake the meter and illuminate the screen.
- If the STATUS SCREEN is not shown (check the upper right corner), this screen will need to be accessed.

  1) Open the clear plastic case lid by unlatching the two latches on the right side.
  2) Press the MAIN MENU key
  3) Press the "STATUS" option
  4) the STATUS SCREEN should now be displayed

- Read the total flow in cubic feet (cf) and the total rainfall (in) from the screen and record these values on the Shut-Down section of the *Station Visit Checklist for Set-Up/Bottle Replacement/Shut-Down Form* at the designated space.

Complete sample bottle labels

- Complete the bottle label for each filled and partially filled bottle. This task can be performed for all labels at once using the information from the just-completed Sample Identification Form.
- For writing ease, perform this task under cover to keep the labels and pages as dry as possible.
- Complete the lower portion on the front page of the Field Data Log at the same time.

Remove bottle

- Lift off the control section off the base using the handles on the side of the sampler.
- Remove the lid from the Ziploc bag and place it securely on the bottle.
- Remove the filled or partially filled bottle.

  1) Dry off the bottle
  2) Place the completed label on the bottle, not the lid
  3) Place a strip of clear packing tape over the label
  4) Place the bottle in a cooler

- Pack each cooler with ice to keep samples cool.

Site Exit

- Complete the Set-Up section of the Station Visit Checklist in the *Set-Up/Bottle Replacement/Shut-Down Form*. Field crews must complete the form and document the findings on this form before leaving the station.

- Fill in the *Site Visit Log* (Appendix C). Site visit log is located in the front of the station notebook. Place the notebook back on the shelf.

- File completed forms in field notebook.

- Secure site. Remove any waste from the site, carefully close the housing lid, lock up the enclosure.

- Inspect the sampler strainer and flow probes. If accessible from the outside, inspect the sampler strainer and flow probes, note any problems (debris or damage to the probes, strainer, tubing, cords).

10.6 Special Considerations for Cold Weather Monitoring

Cold weather sampling activities may be hampered by two potential difficulties that are not present in moderate and warm weather: snow accumulation and freezing of sample water in the sample line. Measures to accommodate these potential problems will include:

- regular snow removal

- insulation of the sampler cover and sample tubing conduit

- maintaining a positive gradient from sample intake to sampler pump

- checking of air temperature prior to and during sample collection

- additional checking of the equipment by field crews, and

- manual grab sampling during times when autosamplers cannot be used.

10.6.1 Snow Removal

Accumulation of snow may interfere with the ability of field crews to access the monitoring equipment and perform sample collection functions. This is especially true as highway snow removal activities may cause additional accumulations along the highway right-of-way, which is where the monitoring stations are located.

A snow removal contractor will be retained to provide regular clearing of snow at each monitoring station, to ensure that field crews have space for vehicle parking and have access by foot to the equipment enclosures, and that the enclosures themselves are free and clear of snow. This function should be performed on a regular basis (after every snowfall), to reduce the build-up of snow throughout the season, and to ensure that field crews have access to the stations at all times for monitoring activities.

10.6.2 Equipment Insulation

To help prevent freezing of the water in the sample line, the sample tube conduits will be insulated with pipe insulation wherever they are exposed to the outside, and the sampler cover will be lined with insulation material to help retain heat generated by the sampler.

10.6.3 Sampler Tube Gradient/Purge

To help prevent the freezing of water in the sampling line, the sampling tube will continue to be set so as to maintain a positive gradient from intake to sampler pump. This will allow sample water to drain fully from the tube after each aliquot.

The field crews will also ensure that the Sigma 900 sampler will continue to be programmed to perform a final purge after each sample aliquot is collected.

10.6.4 On-site Checking

Field crews will measure air temperature prior to initiating sampling, and then at frequent intervals during sample collection. Sampling should commence only when the air temperature exceeds 32°F, and sampling should be discontinued if the air temperature falls below that level.

Field crews will also check the sampling train from intake strainer to composite bottle for ice before initiating sampling and at frequent intervals during sample collection. If all other ambient conditions (air temperature, sample flow, etc.) are conducive to monitoring, a portable heating unit can be used to thaw frozen components and allow sample collection to proceed. Care must be taken in case to avoid any introduction of contaminant into the sample tubing or composite bottle.

Even with these precautions, it is possible for some water to remain in the sampler pump tubing. In the event that sample water is retained in the pump tubing and freezes, this could bind up the sampler pump. This would likely cause the sampler's fuse to blow before any damage occurs to the pump. Field crews will therefore need to check pump operation and verify that the fuse has not blown and that the unit is still operational. Extra fuses will be maintained on hand to cover this possibility.

10.6.5 Manual Grab Sampling

Snowmelt runoff may occur under weather conditions when autosamplers cannot be used. For example, snowmelt runoff may occur during a winter storm event when temperatures are below freezing, but snow control operations create runoff by using sand and salts to melt the snow falling on the roads. Through attempts to conduct automated monitoring it may be discovered that, despite the field crews' best efforts, the autosamplers are unreliable under cold-weather conditions, and the effort required to keep them operational may be better served to simply collect manual grab samples. If this situation occurs, several grab samples may be taken to characterize an extended snow melt period (e.g., every four hours for a maximum of 24 hours). Manual grab sampling will only be conducted as long as the sites are accessible and snow control operations will not endanger the field crews.

10.7 Snowmelt Runoff Monitoring

Snowmelt runoff monitoring differs fundamentally from stormwater runoff monitoring in that sampling can be initiated in response to runoff flow in the absence of precipitation. Once substantial snowfall has occurred, field crews will need to track weather conditions so as to be alert to the possibility of significant snow melt. When the desired conditions occur (warming temperatures after a period of snow accumulation or when sand and / or salts are applied to melt the snow that is falling on the roads), field crews will program the automated equipment to collect flow-proportioned composite samples of the melting snow. This will include the following modifications to the typical runoff monitoring protocols:

- Field verification of conditions
- Automated equipment programming
- Visual and photographic observations

These modifications are described below.

10.7.1 Field Verification of Conditions

Field crews will verify that snowmelt runoff is occurring, and that there are no obstructions to runoff flow. As described above for cold weather monitoring, field crews also will verify the air temperature. If the temperature is above 32°F, and there is no ice present in the sampling tube, autosamplers will be used. Otherwise the event will be aborted or manual grab sampling may be performed, with multiple grabs collected on a time-paced basis dependent on the duration of the expected runoff.

10.7.2 Automated Equipment Programming

During the initial year of snowmelt monitoring, field crews will have to make best-guess assumptions about the expected flow volume that will be observed during a given monitoring period. Initially, it is recommended that the flow pacing be programmed at the same level as for a moderate (say 0.5") rainfall event. To ensure composite sample representativeness, the goal will be to collect at least eight aliquots for each monitoring event, with a minimum number of six aliquots, as specified in the Guidance Manual for a small storm event.

Because snow melt may continue at varying rates for days, it will be necessary to limit the composite collection period to provide some degree of standardization and permit compliance with sample holding time requirements. The snowmelt sampling composite period therefore will be limited to 24 hours from the start of composite sampling. Field crews will also make observations of runoff flow rates at various times and in various conditions during the winter / spring snow-melt season to provide better approximations of the runoff volume to be expected from periods of snow melt.

If runoff continues after the initial 24-hour period, single manual grab samples may be collected during subsequent 24-hour periods, at the rate of one or two per day for up to three additional days.

10.7.3 Visual and Photographic Observations

Field crews will make visual and photographic observations before and after each snowmelt runoff-sampling event. These observations will include:

- Approximate depth of snow in snow banks and on the ground
- Weather conditions during week leading up to monitoring event
- Visual condition of snow pack in sampling area
- Photographs of snow pack and snow-melt runoff before, during and after monitoring
- Brief summary of snow management activities conducted by Caltrans

An additional snowmelt monitoring log sheet will be filled out for these events. Refer to the example of the snow melt log sheet in Appendix C.

11.0 Precipitation Water Quality Sample Collection

Precipitation samples will be collected in a high-density polyethylene (HDPE) liner that slips into a 3.5-gallon capacity plastic bucket. The bucket with liner will be pole-mounted in an area having a clear opening to the atmosphere, without vertical obstruction. The pole will extend approximately eight feet above grade. A plastic basket will be affixed to a plate on the top of the pole, and used to hold the bucket. The bucket handle will be attached on to the basket to secure the bucket during use. Refer to Figure 11-1.

At the Echo Summit and Tahoe Airport sites, the mounting pole will be attached to the runoff monitoring enclosure, in the same manner as the rain gage pole. At the Tahoe Meadows site the mounting pole will be freestanding, and will be sunk in concrete in a hole in the ground.

At one site, an automated wet deposition collector (the ADS WDO 2000 Atmospheric Deposition Sampler by N-CON Systems Co., Inc.) will be installed, to provide comparative data for the manually-installed sample collection bucket.

11.1 Pre-Event Set-Up

The sampling liners must be pre-cleaned prior to each monitoring event, according to the composite bottle cleaning protocols used for the runoff composite samples, as specified in Appendix B. The liners will be sealed with plastic after cleaning until they are slipped into the buckets on-site on the mounting poles (see Figure 11-1). The liners must be stored so as to minimize exposure to environmental contamination. Blank samples must be run on the sampling liners in the same manner and using the same schedule as runoff composite samples.

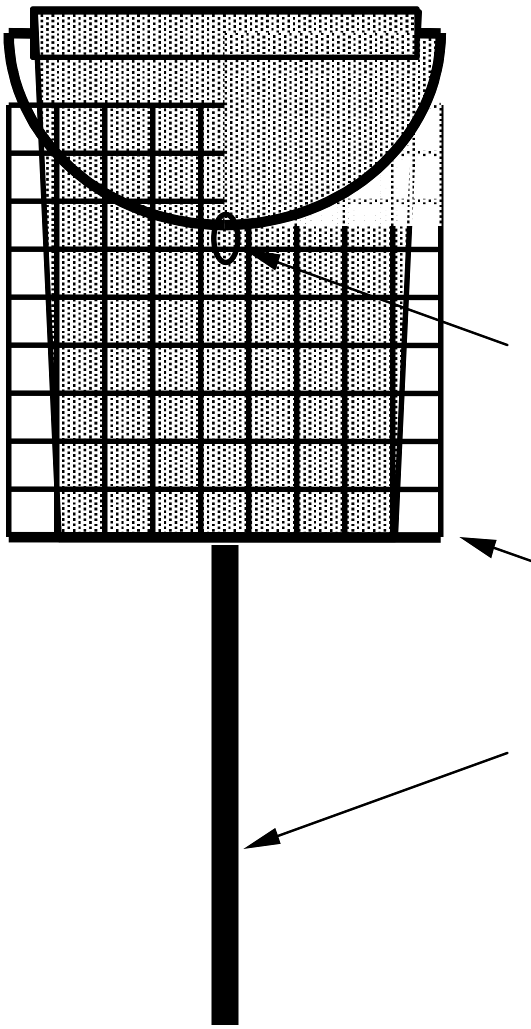


Figure 11-1. Precipitation Monitoring Equipment

Sampling bucket liners will be delivered to the sampling locations, unsealed, slipped into the bucket and then both bucket and liner will be installed on the mounting poles as late as is feasible before the onset of precipitation, so as to minimize collection of dry deposition.

Clean techniques must be used when slipping the clean liners into the buckets and at all other times when handling precipitation sampling containers. This includes wearing gloves and taking additional precautions as described under Sample Collection below.

11.2 Event Monitoring

Buckets with liners will set out on site as close as possible to the onset of precipitation, using clean sample handling techniques.

Rain water and snow samples will be collected directly into the pole-mounted sampling bucket. Snow samples will be allowed to melt in the bucket.

Precipitation samples are particularly susceptible to contamination, due to their relatively low concentrations of pollutants. Care must be taken during all phases of sampling to minimize exposure of the samples to sources of contamination. To reduce potential contamination, sample collection personnel must adhere to the clean sampling techniques presented in Section 10.1 as well as the following rules while collecting precipitation samples:

- Never unseal the precipitation-sampling liners near a running vehicle. When possible, park the field vehicles out of the immediate sample collection area.
- Always wear clean, powder-free nitrile gloves when handling precipitation sampling liners and sample bottles.
- Never touch the inside surface of the sample bucket liner, even with gloved hands.
- Never allow the inner surface of the sample bucket liner to be contaminated by any material other than the sample water.
- Never allow any object or material to fall into or contact the collected sample water.
- Do not allow rainwater to drip from rain gear or other surfaces into sample buckets.

11.3 Post Event Activities

At the conclusion of the monitoring event, the samples collected in the precipitation sample buckets must be removed from the mounting poles as soon as possible after precipitation has stopped. The samples will then be poured directly into clean HDPE one-liter bottles. The bottles will be capped and labeled following the sample designation shown in Section 9.2.

All samples will be held at 4°C (on ice or refrigerated) until analysis. Samples will be delivered to laboratories along with the runoff characterization samples, using the procedures described in Section 13.

12.0 Sediment Size Distribution and Quality Sample Collection

Several potential concerns have been identified with the current sampling technique for measuring sediment during storm events:

- The sampling inlet is typically screened to prevent clogging of the automatic sampling equipment. This also effectively screens out the larger size fractions from the sediment that is collected. In addition, the larger size sediments may not be collected due to gravity separation within the sampling tube.

- Sampling protocols used to measure sediment require large volumes of stormwater. For example, a sieve analysis may require approximately 120 grams sediment. Assuming an average total suspended solids (TSS) of 200 milligrams per liter (mg/L), approximately 600 liters (160 gallons) of water sample would be needed to collect enough sediment for this analysis. Table 12-1 summarizes other sample volumes required for different TSS concentrations.

- The sampling inlet is sometimes positioned above the invert of a flow channel to prevent clogging of the automatic sampler. As a result, larger size sediments moving near the bottom of the channel by rolling, sliding, or skipping may not be collected, thereby not incorporating the larger sediment particle sizes in the sediment sampling.

Table 12-1
Example Sample Volumes Required for Sieve Analysis

TSS Concentration (mg/L)	Water Sample Volume Required (gallons)
20	1,600
200	160
2,000	16

This SAP details preliminary sediment sampling protocols for Caltrans to implement. In a future study, sediment analytical results obtained from following these new protocols will be compared to the previous years' sediment analytical results to determine if the protocols can be improved. In addition, the previous sediment sampling results will be evaluated for possible adjustment to allow combination with results under the new protocols for statistical analysis of sediment concentrations.

12.1 Background

12.1.1 Sediment Terminology

Figure 12-1 is a diagram of sediment size (diameter in microns [µm]) for various classifications of solids expected in stormwater runoff.

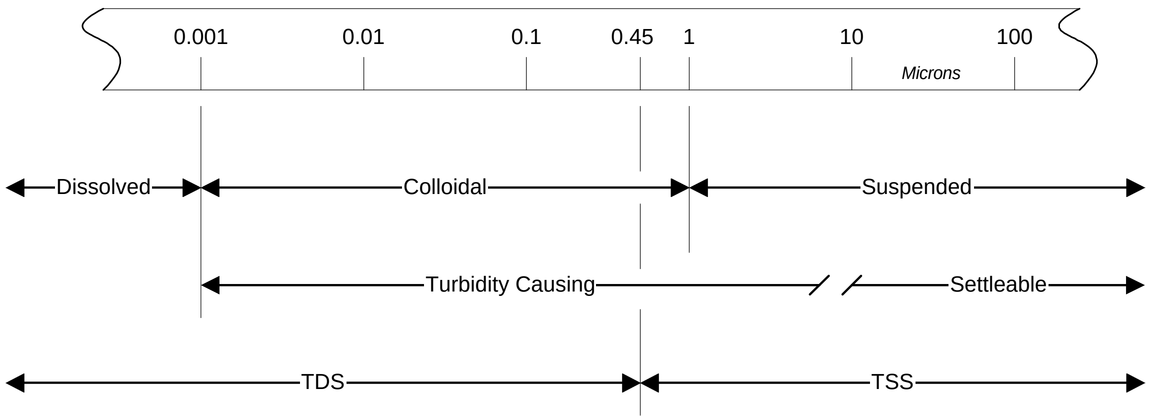


Figure 12-1. Sediments Classification

As shown, stormwater runoff will contain dissolved solids (<0.001 µm), colloidal solids (0.001 – 1 µm) and suspended solids (>1 µm). Colloidal solids (if present) and the smaller suspended solids (less than about 10 µm) typically are turbidity causing while the larger suspended solids (greater than about 10 µm) are typically settleable. Settleable solids will settle out due to gravity over time, with the smaller particles requiring longer periods of time to settle. Colloids are microparticles or macromolecules that remain suspended in waters because their gravitational settling is less than 0.01 cm/sec (Stumm et. al 1981). Differentiation between the various categories of solids generally will vary depending on such parameters as particle density, chemical composition (organic versus inorganic), flow rate, and turbulence. The cut-off between turbidity causing and settleable solids is especially sensitive to these parameters and will, therefore, vary depending on site conditions. Conversely, the cut-off between total dissolved solids (TDS) and total suspended solids (TSS), which are determined by standard analytical methods, is operationally defined at 0.45 µm. The 0.45 µm filtrate (measuring TDS) will contain turbidity causing colloids (if present) in addition to dissolved solids, while the particles retained on the 0.45 µm filter (measuring TSS) will consist primarily of particles in the suspended solids category (both turbidity causing and settleable) with some larger turbidity causing colloids.

12.1.2 Sediment Sampling Methodologies

Sieve analysis is limited to sediments with particle sizes greater than 20 µm (#635 mesh). For particles less than 20 µm, filter paper (especially membrane filters) is required to obtain samples for size fractions and chemical analyses. Gravimetric methods to measure the quantity of various size fractions. Size fractions can also be determined using hydrometers and/or particle counting methods.

The screen on the sample intake of the automatic sampler currently utilized at the Caltrans stations may prevent it from collecting all of the suspended sediment. Therefore, the sediments obtained from the automatic sampler may not fully represent the total suspended sediment.

Two primary issues need to be addressed in the sampling of stormwater runoff sediment:

- Accurate measurement of total sediment load introduced into the system due to stormwater runoff.
- Collection of a representative sample of sediment.

The primary objectives of this project are to preliminarily characterize sediments in highway runoff and to determine a method to collect the total sediment load for widespread application. Another project objective is to determine the correlation between the sediments currently measured using a typical autosampler installation and the total sediment load (i.e. how much was unmeasured).

12.1.3 Sediment Characterization

The physical and chemical characteristics of the sediment affect its mobility and bioavailability to contaminants. For example, the oxidation / reduction status influences the retention or release of metals; the organic matter content affects the affinity of metals and nonpolar organic contaminants to the sediment; and the size and texture (sand, silt, or clay) of the particles affects which contaminants are more readily adsorbed to the sediment particles.

In addition, several particular constituents are found in highway runoff due to exposure to traffic. Typical constituents found in highway runoff and their sources are summarized in Table 12-2.

Table 12-2
Sources of Pollutant Constituents

Constituent	Primary Sources
Particulates	Pavement wear, vehicles, atmosphere, maintenance, snow/ice abrasives, sediment disturbance
Nitrogen, Phosphorus	Atmosphere, roadside fertilizer use, sediments
Lead	Tire wear, lubricating oil and grease, bearing wear, atmospheric fallout
Zinc	Tire wear, motor oil, grease
Iron	Auto body rust, steel highway structures, engine parts
Copper	Metal plating, bearing wear, engine parts, brake lining wear, fungicides and insecticides use
Cadmium	Tire wear, insecticide application
Chromium	Metal plating, engine parts, brake lining wear
Nickel	Diesel fuel and gasoline, lubricating oil, metal plating, brake lining wear, asphalt paving
Manganese	Engine parts
Bromide	Exhaust

Table 12-2
Sources of Pollutant Constituents

Constituent	Primary Sources
Cyanide	Anticake compound used to keep deicing salt granular
Sodium, Calcium	Deicing salts, grease
Chloride	Deicing salts
Sulphate	Roadway beds, fuel, deicing salts
Petroleum	Spills, leaks, blow-by motor lubricants, antifreeze, hydraulic fluids, asphalt surface leachate
PCBs, Pesticides	Spraying of highway right of ways, atmospheric deposition, PCB catalyst in synthetic tires
Pathogenic Bacteria	Soil litter, bird droppings, trucks hauling livestock/stockyard waste
Rubber	Tire wear

Source: Kobringer, 1984.

12.2 Event Monitoring

Two sediment-sampling approaches are proposed for sampling Caltrans drainage facilities – a water volume approach and a filter approach. A detailed description of each approach and a discussion of the advantages and disadvantages of each approach follows.

12.2.1 Sediment Sample Collection – Water Volume Approach

The water volume approach is being pilot tested using two techniques: autosampling and manual grab sampling. The same autosampling set-up used to collect water samples of the stormwater runoff will be used to collect samples for sediment analysis. Individual aliquots will be collected on a flow-paced basis (e.g., collect 1 gallon every 100 cubic feet of runoff) and deposited into a container. When the container fills, the contents will be field filtered as described in Section 12.3. Successive samples will be collected and filtered for subsequent sampling intervals. The total volume of stormwater passing through the inlet structure will be recorded by the flow meter.

Figure 12-2 is a general conceptual diagram illustrating the manual grab sampling technique. This collection procedure requires manual collection of a large sample volume that is representative of the runoff discharged into the sediment trap during a storm event. In general, a bucket will be used to manually collect samples every time the autosampler collects a sample. The bucket will be placed below the nappe of the flow as it discharges into the sediment trap. The weir level in the sediment trap will be set to allow the sample to be collected. When the bucket fills, the contents will be field filtered as described in the subsequent paragraph entitled Sample Preparation. Successive samples will be collected and filtered for subsequent sampling intervals.

A flow diagram of the collection and sampling procedure for the water volume approach is shown in Figure 12-3. The two sampling techniques are run in parallel. Results of the grain size distribution analysis will be used to identify any difference in the samples collected by the autosampler and manually. The individual grain size samples will then be analyzed for the chemical analytes listed in Table 5-2. Samples on a particle size basis will be combined with samples from all approaches (auto water volume, manual water volume, and filter) to ensure a sufficient sample size is generated for each particle size or range of sizes.

Sample Preparation

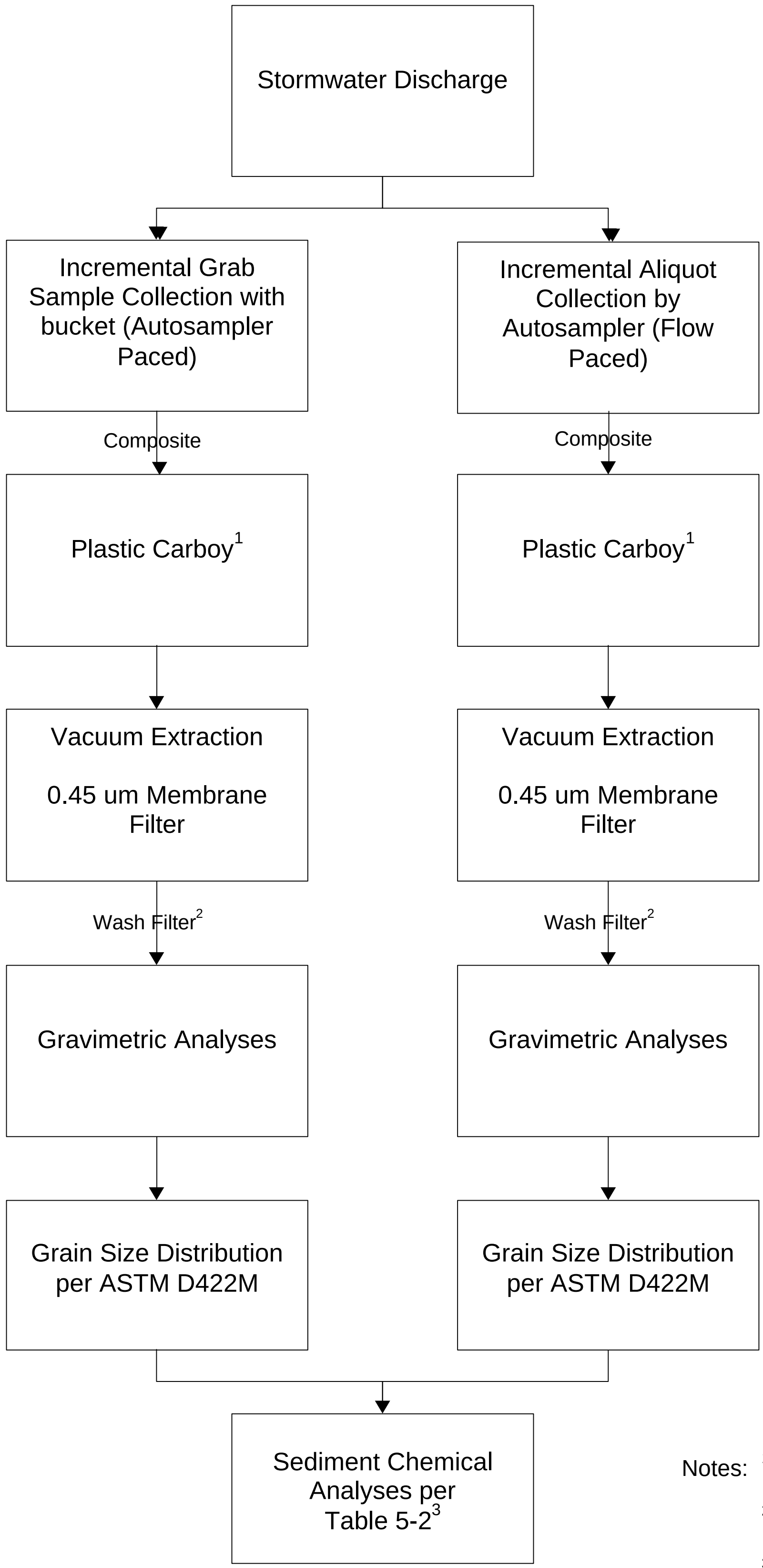
Immediately following collection, the samples will be filtered through a 0.45 µm membrane filter using a Gilson HM-8 vacuum extractor (Figure 12-4) connected to a Gilson MA-32 vacuum pump (Figure 12-5). Successive filter papers will be used as necessary.

After separating the sediments, the filter paper(s) will be washed with demineralized water to remove the sediments from the filters. Gravimetric analyses will be used to determine the mass of any solids that may remain on the filters following the washing step. The sediments / wash water will be evaporated at a temperature not to exceed 105 C. The resulting sediments will then be analyzed for particle size fractions and quality on a per particle size basis as shown in the lower portion of Figure 12-3.

Sampling Equipment

The following sampling equipment is needed to conduct this sampling approach:

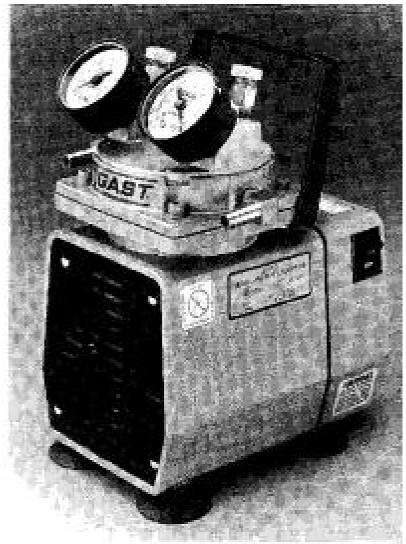
- Clean, polyethylene bucket
- Nylon rope
- Vacuum Extractor (Gilson HM-8 or equivalent)
- Vacuum Pump (Gilson Ma-32 or equivalent)
- Filter papers (Whatman 934AH or equivalent)



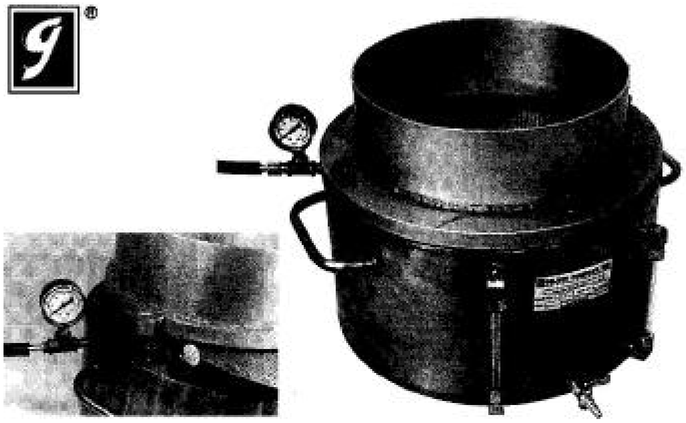
Notes:
[1] Similar container/size may be substituted.
[2] Gravimetric analyses conducted on filters.
[3] May be combined with fractions from filter approach.

Figure 12-3. Flow Diagram for Water Volume Approach

Figure 12-5. Vacuum Pump.



MA-32



HM-8

Figure 12-4. Vacuum

Pre-Event Preparation

Modification of the sediment traps may be necessary to allow the bucket to be lowered through the top to collect sample of runoff discharging into the trap. A non-clogging (open-topped) flume may be added at the entrance to the trap inlet to reduce the cross-sectional area entering the trap at low flows. This would allow for quicker collection of the total sample and provide sufficient flow depth for the strainer of the autosampler. At high flows, the flume would be overtopped and not affect the flow.

Filters (0.45 µm membrane) will be dried and weighed prior to use with the vacuum extractor. Following filtration and washing to remove sediments, the filters will again be dried and weighed to allow determination of the mass of any solids remaining on the filter.

Measured Suspended Sediment Load

The method detailed above will collect the total sediment load for various time increments during the storm event. This total sediment load will include the suspended sediment load, which will also be representative of the various time increments.

12.2.3 Sediment Sample Collection – Filter Approach

The filter approach utilizes a passive filtration system to collect the majority of the sediment load carried along by the runoff at each site. The runoff is directed through a series of filters that collect all the sediment that are greater than 20 µm in size.

A general conceptual diagram illustrating this approach is shown in Figure 12-6. When it rains the resulting runoff pickups the sediment and carries it along. The sediment particles vary in size as depicted by the different sizes of dots in the pool of runoff. The particle size classes represented by the dots were selected for illustrative purposes only.

At the two Tahoe Basin monitoring sites, the runoff is first directed to a double barrel sand trap. These traps are comprised of two 36-inch diameter barrels about five to ten feet deep. A slot in the first lid (shaded area shown at the top of each barrel) allows the runoff to enter from the roadway. A pipe connects the two traps. A second slot is located near the lid of the second barrel that allows the treated runoff to exit. The inlets and outlets are placed so runoff does not backup onto the roadway when the traps are flowing full. The traps are designed to cause the larger and heavier sediment particles to settle to the bottom of either trap. The treated runoff is then discharged to the downstream area along with any sediment that is still in suspension. At the Zinfandel site (Station 3-07), the runoff with the entire sediment load is directed off the highway and into a grassy area. From this point the runoff at both the Tahoe Basin sites and the Zinfandel site either infiltrates into the ground or continues to the nearest drainage system.

The passive filter approach system is designed to collect the sediment that settles to the bottom of each barrel and is carried along with the runoff. Bags made of filter fabric material (#635 [20 µm]) are attached along the inside perimeter of each sand trap barrel prior to the selected monitoring event. The filter bags will fit snugly against the inside of the barrel to prevent any flow from flowing under the bag. In addition, a four-foot by two-foot by two foot filter box is placed under the nappe of the flow as it discharges from the traps or, in the case of the Zinfandel site, from the highway. The filter box contains a stack of cloth filters with progressively smaller pore sizes (#200 [75 µm], #400 [38 µm], and #635 [20 µm]. A diagram of the sampling set up is shown in Figure 12-7. At the Zinfandel site, only the filter box shown on the right side of Figure 12-7 will need to be present.

Following the monitoring event, the filters will be removed from both the barrels and box, sealed in suitable containers, labeled, and transported to the sediment laboratory. Sediments that have collected will be removed and analyzed for particle size and chemical constituents.

Sediment with sizes less than 20 µm will pass through the filter bags and box as shown by the smallest dotes in Figure 12-6. The autosampler or manual grab method described earlier will collect a sample with this size range (0 to 20 µm) for analysis. The total volume of stormwater runoff flowing through the station during the monitoring event will be recorded by a flow meter.

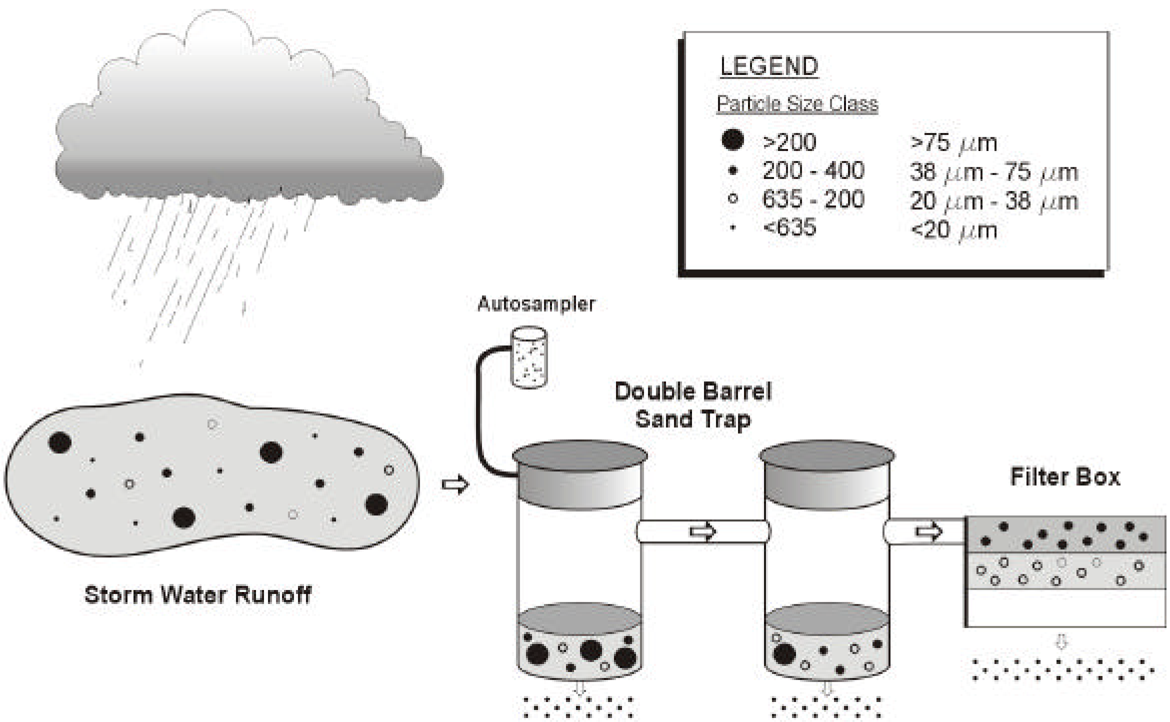


Figure 12-6. Conceptual diagram illustrating the filter approach.

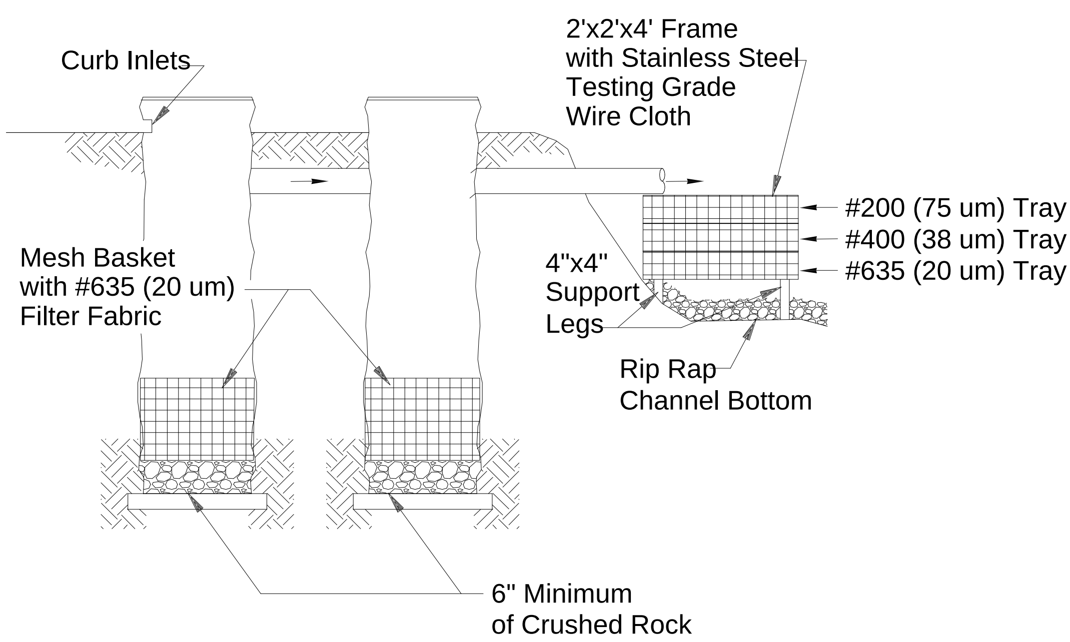


Figure 12-7. Sediment Sampling - Filter Approach

Sample Preparation

The filter fabric and cloth sheets will be weighed prior to use at the site for collection of sediments. At the laboratory, the filters will again be gravimetrically analyzed then flushed to remove the sediment from the filters. Following collection of sediments and washing to remove the sediments from the filters, the filter fabric sheets will be dried and re-weighed in order to calculate the amount of sediment not removed by washing (e.g., entrained within the filter pores). This step is necessary to evaluate the amount of fine sediments that are not included in the grain size and chemical analyses.

Figure 12-8 is a flow diagram of the entire filter approach. Stormwater runoff will be directed through all the filters. On a regular basis (after individual storm events or on a monthly basis) the filters will be retrieved and sent to the laboratory for analysis.

Sampling Equipment

The following sampling equipment is needed to conduct this sampling approach:

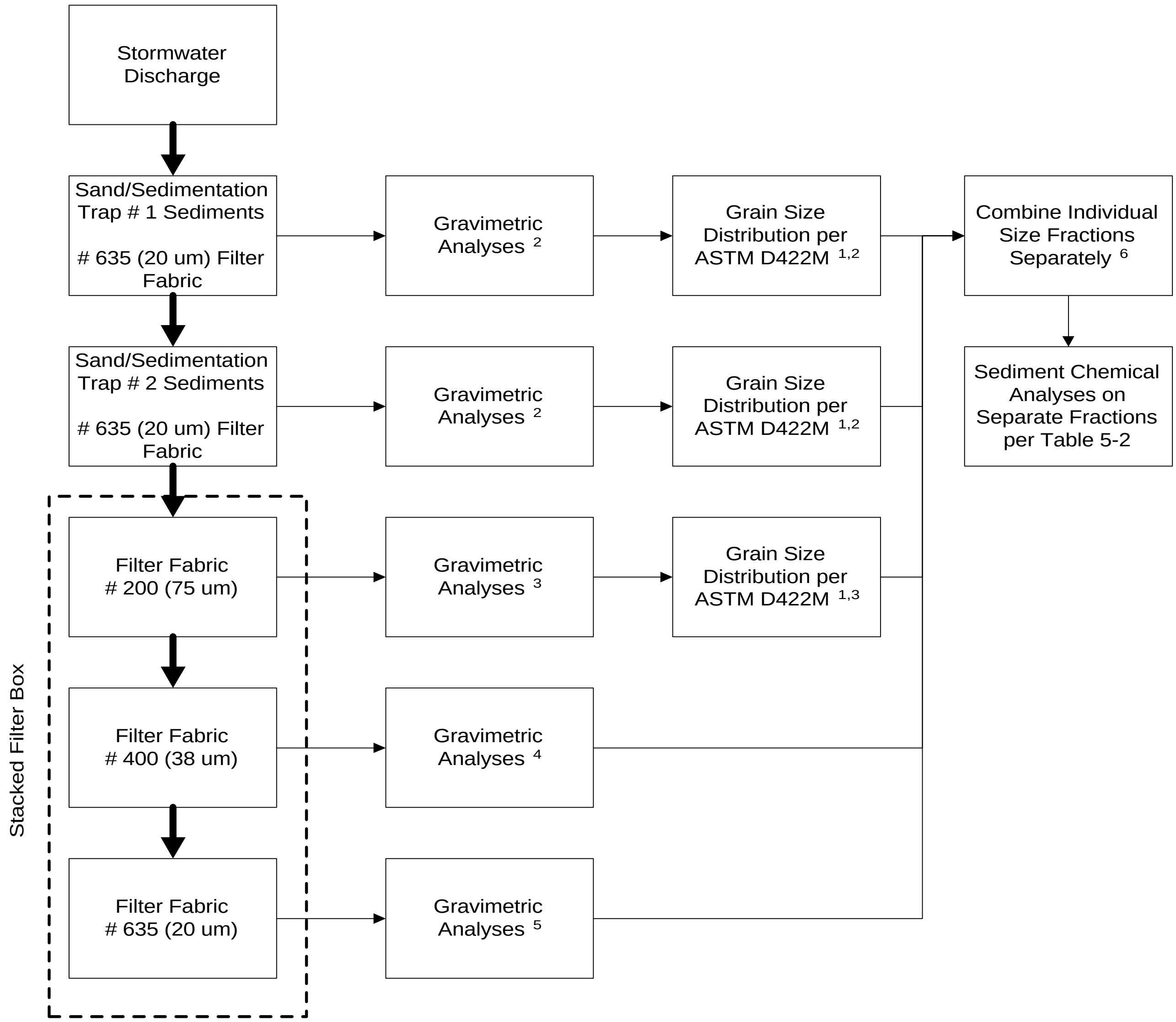
- Filter fabric material (#200 [75 µm] mesh, #400 [38 µm] mesh, and #635 [20 µm] mesh)
- Steel boxes for filter fabric material with three trays for #200 [75 µm] mesh, #400 [38 µm] mesh, and #635 [20 µm] mesh
- Mounting ring to hold the filter fabric bag in placed in sediment trap barrel
- Metal hook with rope capable of hauling up the filter bag from the inlet after sampling
- Large sample containers to hold filters for transport from field to laboratory

Pre-Event Preparation

Modification of the sediment traps may be needed to attach the filter bags to the sides and bottoms of the sediment traps. Prior to sampling, the inlets will be thoroughly cleaned. Six inches of crushed rock should be placed at the bottom of each inlet to prevent the bags from getting caught in the dirt bottom of the traps.

Measured Suspended Sediment Load

The method detailed above will collect a high percentage of the total sediment load for the entire storm event. An additional portion of the entire suspended sediment load will be collected by the filter fabric basket. However, because the filter fabric will have a minimum apparent opening size of 20 µm (actual opening size will depend on potential for clogging), suspended sediments smaller than 20 µm will not be captured. However, suspended sediments smaller than 20 µm (#635 mesh) will be collected by the water volume method. Therefore, grain size and chemical analysis of the water volume samples will be important.



Notes: [1] Sieve sizes modified to include those specified in Table 5-3.
[2] Potential particle size range: >4750 um to >20 um (14 fractions).
[3] Potential particle size range: >4750 um to >75 um (12 fractions).
[4] Potential particle size range: <75 um to >38 um (1 fraction).
[5] Potential particle size range: <38 um to >20 um (1 fraction).
[6] Size fractions will be composited based on weight.

Large arrows indicate stormwater flow direction.
Small arrows indicate sample processing.

Figure 12-8. Flow Diagram of Filter Approach

12.3 Evaluation of Sediment Sampling Approaches

Water Volume Approach

Advantages

- Captures the entire sediment load (bed sediments and suspended sediments) during sampling increments.
- Allows ability to target monitoring to certain portions of the storm (e.g., first flush).
- Does not interfere with the normal flow of the system – backups unlikely.
- Requires very little additional field equipment.
- Requires minor modifications to current sampling station.
- Not easily open to vandalism.

Disadvantages

- Does not capture the sediment load (bed sediments and suspended sediments) for the entire storm event. Sampling is incremental, so all sediments during an event are not captured.
- Requires field-sampling crews to be at the monitoring stations at the beginning of the storm event in order to collect representative sediment increments (Logistics).
- Requires field crews to be present during potential thunderstorm, blizzard conditions (Safety).
- Requires field crews to lift full buckets of water from inlets during storm runoff conditions and potential thunderstorm, blizzard conditions (Safety).
- Requires samples to be manually collected throughout the duration of the monitoring event (Labor intensive).
- Requires sufficient stormwater runoff to allow collection of a bucket of stormwater.
- Samples may not be representative if first flush is missed or if sampling interval is interrupted.
- Handling and transport of large sample volumes is difficult and unwieldy.
- Processing and analyses of large sample volumes in laboratory is difficult.

Filter Approach

Advantages

- Captures and filters all of the flow and thereby all of a large portion of the total sediment load in the stormwater. Inclusion of the sediment collected by the autosamplers is, therefore, important.
- Does not require field-sampling crews to be manually collecting samples during the monitoring event (Less labor intensive).
- Does not require field crews to be present at monitoring site throughout storm event (Safety).
- Collects sediments for duration of the monitoring event.
- Could be applied to snow melt conditions or very long storm events.

Disadvantages

- Does not capture the fine-grained suspended sediments (<20 µm that pass through the filter fabric). Inclusion of the sediment collected by the autosamplers is, therefore, important.
- Handling and transport of filter mats is required after storm events.
- Could clog downstream filter box and cause overflow causing sediments to be lost.
- Requires specially designed filter equipment, which would have to be fabricated and installed at monitoring sites.
- Requires modifications to the CMP inlet - specifically covering bottom of inlet with crushed rock.
- Downstream filter box is open to vandalism.

13.0 Sample Delivery/Shipping

Following the collection of each sample, the sample bottle label must be completed, the sample kept on ice, the chain-of-custody form filled out, and the sample packaged for shipping to the laboratory.

13.1 Chain-of-Custody

Chain-of-custody (COC) forms will be filled out for all samples submitted to the laboratory. Sample date, location, and analyses requested shall be noted on each COC. Additionally, the note “filter for dissolved metals immediately” shall be added to all composite sample COC forms. COC forms shall be placed in a Ziploc bag inside the sample cooler for shipment to the laboratory. Copies of all COC forms shall be kept with field notes.

13.2 Sample Packaging/Shipping

All samples will be kept on ice from the time of their collection to the time of receipt by laboratory personnel. It is imperative that all samples be analyzed within maximum holding times (refer to Table 5-1). The bottles are placed in coolers with adequate ice to keep samples cool until receipt by the laboratory. Coolers should be securely taped shut and properly labeled. Samples will be shipped Golden State Overnight delivery service.

To schedule sample delivery call:	(800) 322-5555
Ship water samples to:	
CalScience Environmental Laboratories	Attn: Steve Nowak (714) 895-5495
7440 Lincoln Way	
Garden Grove, CA 92841	
Ship sediment samples to:	
CDM Sediment Laboratory	Attn: Rick Chappell (303) 642-5500
1331 17th Street, Suite 1200	
Denver, CO 80202	

14.0 QA/QC Sample Collection Methods

QA / QC samples should be collected for the samples and analytes specified in the QA / QC sample schedule (Table 14-1). Specific collection methods for each type of quality control sample type are described below. QA / QC samples are collected as grabs or composites depending on the normal requirements of the constituents to be analyzed.

<u>Field Blank</u> (total recoverable metals and TOC / DOC only)

Composite sample field blanks (e.g., for metals analysis) should be collected at the time that the final composite bottle is removed from the autosampler. Blank water provided by the laboratory will be poured directly into a clean composite container on site.

Field blanks should be submitted "blind" to the laboratory (labeled as normal samples, with a fake site name).

<u>Field Rinsate Blanks</u> (sediment total recoverable metals only)

Composite sample field rinsate blanks (e.g., for metals analysis) should be collected at the time that the final composite sediment sample is removed from the filter. Blank water provided by the laboratory will be poured directly into a clean composite container on site. Field rinsate blanks should be submitted "blind" to the laboratory (labeled as normal samples, with a fake site name).

Matrix Spike / Duplicate (total recoverable metals only)

Matrix spike and matrix spike duplicate (MS / MSD) analyses should be requested on a specified sample for each storm for trace metals. No special sampling considerations are required. However, additional sample volume must be collected for each analysis.

Field Duplicate / Split (all analyses)

Grab sample field duplicates should be collected immediately following the collection of normal grab samples.

Composite sample field splits should be produced in a clean environment prior to shipment to the laboratory. Double the normal composite sample volume is required for these samples. The composite sample field split is generated by agitating the composite sample until it is well mixed and pouring half of the composite volume into a second clean composite bottle using clean techniques. The field duplicate should be submitted “blind” to the laboratory (labeled as normal samples, with a fake site name).

Laboratory Duplicate (all analyses)

No special sampling considerations are required for composite sample laboratory duplicates. However, double the normal composite volume must be collected and laboratory duplicate analysis requested on the chain-of-custody form. Laboratory duplicates should be collected for the sites and storm events specified in the QA / QC schedule (Table 2). Grab sample laboratory duplicates should be collected immediately following the collection of normal grab samples.

Table 14-1
Quality Control Sample Collection Schedule

Location	Monitoring Event					
	1st Event	**2nd Event**	**3rd Event**	**4th Event**	**5th Event**	**6th Event**
Runoff Water Quality Events						
Echo	MS/MSD	Field Blank	Lab Duplicate	MS/MSD	Field Blank	Field Duplicate
Airport	Lab Duplicate	MS/MSD	Field Blank	Field Duplicate	MS/MSD	Field Blank
Tahoe Meadows	Field Blank	Field Duplicate	MS/MSD	Field Blank	Lab Duplicate	MS/MSD
Precipitation Water Quality Events						
Echo	MS/MSD	Field Blank	Lab Duplicate	MS/MSD	Field Blank	Field Duplicate
Airport	Lab Duplicate	MS/MSD	Field Blank	Field Duplicate	MS/MSD	Field Blank

Table 14-1
Quality Control Sample Collection Schedule

Location	**Monitoring Event**					
	1st Event	**2nd Event**	**3rd Event**	**4th Event**	**5th Event**	**6th Event**
Tahoe Meadows	Field Blank	Field Duplicate	MS/MSD	Field Blank	Lab Duplicate	MS/MSD
Sediment Size Distribution and Quality Events						
Echo	MS/MSD	Field Rinsate Blank		MS/MSD		Field Duplicate
Airport		MS/MSD	Field Rinsate Blank	Field Duplicate		
Zinfandel	Field Rinsate Blank		MS/MSD		Field Duplicate	

None: If more that six events are monitored, repeat requirements beginning with 1st event requirements.

15.0 QA/QC Data Review

15.1 Initial Data Quality Screening

When the laboratory reports are received following each monitored storm event, it is important to check the reported data as soon as possible to identify errors committed in sampling, analysis or reporting. The laboratory must report results in a timely fashion (typically within 30 days of receipt of the samples) and the results must then be reviewed immediately upon receipt. This may allow for re-analysis of questionable (out-of-range) results within the prescribed holding time. The initial screening includes the following checks:

- ✓ Completeness. The chain of custody forms should be checked to ensure that all laboratory analyses specified in the sampling plan were requested. The laboratory reports should also be checked to ensure that all laboratory analyses are performed as specified on the chain of custody forms, including the requested QA / QC analyses.

- ✓ Holding Time. The lab reports should be checked to verify that all analyses were performed within the prescribed holding times.

- ✓ Detection Limits. The reported analytical detection limits should meet or be lower than the levels agreed upon prior to laboratory submission.

- ✓ Reporting Errors. On occasion laboratories commit typographical errors or send incomplete results. Reported concentrations that appear out of range or inconsistent are indicators of potential laboratory reporting problems, and should be investigated when detected. Examples of this would be a dissolved concentration greater than the corresponding total recoverable concentration, or a constituent concentration orders of magnitude different than concentrations reported for the same constituent for other events.

Irregularities found in the initial screening should immediately be reported to the laboratory for clarification or correction. This process can identify and correct errors that would otherwise cause problems further along in the data evaluation process, or in subsequent uses of the data for higher-level analysis. When appropriate, reanalysis of out-of-range values can increase confidence in the integrity of questionable data.

15.2 Detailed QA/QC Data Review

The data quality evaluation process is structured to provide checks to ensure that the reported data accurately represented the concentrations of constituents actually present in water quality samples. Data evaluation can often identify sources of contamination in the sampling and analytical processes, as well as detect deficiencies in the laboratory analyses or errors in data reporting. Data quality evaluation allows monitoring data to be used in the proper contest with the appropriate level of confidence.

QA / QC parameters that should be reviewed are classified into the following categories:

- Contamination check results (method, field, trip, and equipment blanks)
- Precision analysis results (laboratory, field, and matrix spike duplicates)
- Accuracy analysis results (matrix spikes, surrogate spikes, laboratory control samples, and external reference standards)

Each of these QA / QC parameters should be compared to the data quality objectives listed in Section 6. The key steps that should be adhered to in the analysis of each of these QA / QC parameters are:

1. Compile a complete set of the QA / QC results for the parameter being analyzed.
2. Compare the laboratory QA / QC results to accepted criteria (DQOs).
3. Compile any out-of-range values and report them to the laboratory for verification.
4. Attach appropriate qualitifiers to data that do not meet QA / QC acceptance criteria.
5. Prepare a report that tabulates the success rate for each QA / QC parameter analyzed.

Refer to Section 13 of the Caltrans Stormwater Monitoring Protocols Guidance Manual for specific direction on evaluating the results of contamination, accuracy, and precision checks, and on qualifying data that do not meet data quality objectives.

16.0 Data Management and Reporting

Analytical data for this project must go the data validation procedures outlined in Section 13 of *Guidance Manual: Stormwater Monitoring Protocols, Caltrans, May 2000*. Additionally, electronic and hardcopy data must be filed in an organized and easily accessible fashion. Analytical data must be reported in the format consistent with the Caltrans Stormwater Management Program database. See *Caltrans Stormwater Management Program 1999-2000 Data-Reporting Protocols, 10/18/99* (or latest version) and Section 14 of *Guidance Manual: Stormwater Monitoring Protocols, Caltrans, May 2000* for data reporting guidance.

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Appendix A

Health and Safety Plan

Appendix B

Equipment and Bottle Cleaning Protocols

BOTTLE AND EQUIPMENT CLEANING PROCEDURES

Composite Bottles (carboys)

1. Rinse bottle with warm tap water three times as soon as possible after emptying sample.
2. Soak in a 2% Contrad solution for 48 hours; scrub with clean plastic brush.
3. Rinse three times with tap water.
4. Rinse five times with Milli-Q water, rotating the bottle to ensure contact with the entire inside surface.
5. Rinse three times with hexane, rotating the bottle to ensure contact with the entire inside surface (use 30 ml per rinse).
6. Rinse six times with Milli-Q water.
7. Rinse three times with 2N nitric acid (1 liter per bottle, per rinse) rotating the bottle to ensure contact with the entire inside surface.
8. Rinse six times with Milli-Q water.
9. Cap bottle with Teflon lined lid cleaned as specified below.

Teflon Tubing, Lids and Strainers

1. Make up a 2% solution of Micro soap in warm tap water.
2. Rinse tubing three times with the 2% Micro Solution, wash lids and strainers with micro solution and plastic brush.
3. Rinse three times with tap water.
4. Rinse three times with Milli-Q water.
5. Rinse three times with a 2N nitric acid solution.
6. Soak 24 hours in a 2N nitric acid solution.
7. Rinse three times with Milli-Q water.
8. Seal the tubing on both ends with clean latex material
9. Individually Double-bag tubing in new polyethylene bags properly labeled. Double-bag lids and strainers individually in zip-lock bags.

Cleaning Solutions

2% Contrad = 200 ml concentrated Contrad per full 10L bottle

2% HNO_3 Acid = 80 ml concentrated HNO_3 acid (16N) per gallon of Milli-Q water

2% Micro = 80 ml concentrated Micro per gallon of Milli-Q water

Equipment and handling

1. Safety Precautions - All of the appropriate safety equipment must be worn by personnel involved in the cleaning of the bottles due to the corrosive nature of the chemicals being used to clean the bottles and tubing. This safety equipment must include protective gloves, lab coats, chemically resistant aprons, goggles with side shields and respirators. All MSDS must be read and signed off by personnel.

2. A record book must be kept of each sample bottle washed, outlining the day the bottle was cleaned and checked off for passage of the quality control check.

3. Nitrile gloves must be worn while cleaning and handling bottles and equipment. Care must be taken at all times to avoid introduction of contamination from any source.

Appendix C

Examples of Field Forms

STATION VISIT CHECKLIST FOR
SET-UP/BOTTLE REPLACEMENT/SHUT-DOWN

CHECKLIST TO BE COMPLETED AT EACH STATION
DURING SET-UP, BOTTLE REPLACEMENT, AND SHUT-DOWN
One crew member performs actions, other crew member checks that all actions were completed correctly

Set-Up Crew Names: ________________ Date & time that Set-Up is Completed: ________________

Station Name: ________________ Date & time that Shut-Down is Completed: ________________

SAMPLER INSPECTION	OK/not OK	Observation and/or Action Taken to Correct
Desiccant Indicator (Color)	________	________________
Flow Monitor Connections	________	________________
Pump Tubing Condition	________	________________
Intake Tubing Connections	________	________________
Intake Tubing Condition	________	________________

SET-UP CHECKS

________ Record total flow and rainfall from flow meter status screen
Total Flow (cf): ______
Total Rainfall (in): ______
________ Insert trigger volume , if applicable
________ Review flow meter programming
________ Verify flow meter is "RUNNING"
________ Check battery and replace if voltage is below 12.0 V
Flow Meter Battery Voltage ________
________ Check Sampler program with entries (listed in on-site notebook)
________ Sampler date/time match flow meter date/time
________ Insert sample bottle (check for proper bottle position)
________ Put ice in sampler
________ Remove the lid and put lid in a clean Ziploc bag (place lid on housing shelf)
________ Start Sampler program (confirm “Program Running”)
________ Check the intake lines for kinks and dips in the line
________ Call Storm Control

BOTTLE REPLACEMENT

________ Halt Sampler program; expose base; call Storm Control
________ Record total flow and rainfall from flow meter status screen
Total Flow (cf): ______
Total Rainfall (in): _____
________ Record trigger times
________ Put lids on sample bottles
________ Complete Field Data Log and Sample Identification Form
________ Properly label full sample bottles
________ Place bottles in cooler with ice
________ Place a clean set of bottles in the sampler
________ Check the intake lines for kinks and dips in the line

STATION VISIT CHECKLIST FOR
SET-UP/BOTTLE REPLACEMENT/SHUT-DOWN
(continued)

BOTTLE REPLACEMENT (Continued)

________ Check battery and replace if voltage is below 12.0 V ________

________ Flow Meter Battery Voltage ________

RESTART the sampler program, verify "PROGRAM RUNNING"

________ Call storm event coordinator

SHUT-DOWN CHECKS:

________ Halt Sampler program

________ Record in the Sample Identification Form

________ Put lid on sample bottle

________ Properly label full sample bottle

________ Record total flow and rainfall from flow meter status screen

Total Flow (cf): ______

Total Rainfall (in): ______

________ Complete Chain of Custody Form

________ Complete Field Data Log

________ Shut off sampler

Noted Problems: ____

Actions Taken to Correct Problems: ____

Summary Comments: ____

Site Visit Log

Date	*Time*	*Reason for Visit*	*Name (Printed)*

FIELD DATA LOG

(fill out one for each station visit)

GENERAL

Station ID _Station #_________Your Name___________________

Date_______________________ Field Crew____________________

24-hr Time_______________ (All times local standard time)

COMPOSITE SAMPLERS:

Is this the: **1st** 2nd 3rd or final composite bottle replacement? (CIRCLE ONE)

Bottle #	Sample ID	Sample Volume (e.g., 1/4, 1/2, 3/4, full)	Date, 24-hr Time, Missed Triggers
1			
2			
3			
4			
5			
6			
7			
8			

COMMENTS:

____

____

____

SAMPLE IDENTIFICATION FORM

Station ID Name ……………………………………

24 hr. time ……………………………………

Date ……………………………………

Directions: To fill out the following table, press down on the "time read" key on the sampler pad and hold down until the first sample time appears on the display. After the sample time has been recorded, press the enter key and the second sample time will appear on the display. Continue in this manner until all sample times are recorded on the following table:

Trigger #	Date	Time	Notes (e.g., missed trigger)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31			
32			
33			
34			

Insert the form

PRECIPITATION MONITORING CHECKLIST

Set-Up Crew Names: ______________________ Date & time that Set-Up is Completed: ______________________

Station Name: ______________________ Date & time that Shut-Down is Completed: ______________________

SET-UP CHECKS

______ Record rainfall from flow meter status screen

Total Rainfall (in): ______

______ Clear basket of any debris

______ Unwrap bucket insert using clean sampling techniques

______ Insert the insert into the holding bucket

______ Insert holding bucket into basket

SHUT-DOWN CHECKS:

______ Type of Precipitation

Rainfall ______
Snow ______
Mix ______

______ Carefully remove holding bucket with insert and sample from basket

______ Pour sample into 1-L poly sample containers

______ Put lid on sample bottle

______ Properly label full sample bottle, ID #: ______________________________

______ Record rainfall from flow meter status screen

Total Rainfall (in): ______

______ Complete Chain of Custody Form

Summary Comments:

SNOW MELT LOG SHEET

CHECKLIST TO BE COMPLETED AT EACH STATION

Set-Up Crew Names: ____________________ Date & time that Set-Up is Completed: ____________________

Station Name: ____________________ Date & time that Shut-Down is Completed: ____________________

Approximate depth of snow within drainage area

snow banks before: _____________ after: _____________

ground before: _____________ after: _____________

Weather conditions during week leading up to monitoring event

new snow amount ______________________________________

temperatures ______________________________________

Visual condition of snow pack in sampling area

freshly formed ____

frozen ____

melting ____

discolored ____

Recent snow management activities conducted by Caltrans

salting ____

sanding ____

plowing ____

Runoff Appearance

source ____

color/clarity ____

other ____

Additional comments

STATION VISIT CHECKLIST FOR SET-UP/BOTTLE REPLACEMENT/SHUT-DOWN

CHECKLIST TO BE COMPLETED AT EACH STATION
DURING SET-UP, BOTTLE REPLACEMENT, AND SHUT-DOWN

One crew member performs actions, other crew member checks that all actions were completed correctly

Set-Up Crew Names: ________________ Date & time that Set-Up is Completed: ________________

Station Name: ________________ Date & time that Shut-Down is Completed: ________________

SAMPLER INSPECTION	OK/not OK	Observation and/or Action Taken to Correct
Desiccant Indicator (Color)		
Flow Monitor Connections		
Pump Tubing Condition		
Intake Tubing Connections		
Intake Tubing Condition		

SET-UP CHECKS

________ Record total flow and rainfall from flow meter status screen

Total Flow (cf): ______

Total Rainfall (in): ______

________ Insert trigger volume , if applicable

________ Review flow meter programming

________ Verify flow meter is "RUNNING"

________ Check battery and replace if voltage is below 12.0 V

Flow Meter Battery Voltage ____________

________ Check Sampler program with entries (listed in on-site notebook)

________ Sampler date/time match flow meter date/time

________ Insert sample bottle (check for proper bottle position)

________ Put ice in sampler

________ Remove the lid and put lid in a clean Ziploc bag (place lid on housing shelf)

________ Start Sampler program (confirm "Program Running")

________ Check the intake lines for kinks and dips in the line

________ Call Storm Control

BOTTLE REPLACEMENT

________ Halt Sampler program; expose base; call Storm Control

________ Record total flow and rainfall from flow meter status screen

Total Flow (cf): ______

Total Rainfall (in): _____

________ Record trigger times

________ Put lids on sample bottles

________ Complete Field Data Log and Sample Identification Form

________ Properly label full sample bottles

________ Place bottles in cooler with ice

________ Place a clean set of bottles in the sampler

________ Check the intake lines for kinks and dips in the line

STATION VISIT CHECKLIST FOR SET-UP/BOTTLE REPLACEMENT/SHUT-DOWN (continued)

BOTTLE REPLACEMENT (Continued)

________ Check battery and replace if voltage is below 12.0 V ________

________ Flow Meter Battery Voltage ________

RESTART the sampler program, verify "PROGRAM RUNNING"

________ Call storm event coordinator

SHUT-DOWN CHECKS:

________ Halt Sampler program

________ Record in the Sample Identification Form

________ Put lid on sample bottle

________ Properly label full sample bottle

________ Record total flow and rainfall from flow meter status screen

Total Flow (cf): ______

Total Rainfall (in): ______

________ Complete Chain of Custody Form

________ Complete Field Data Log

________ Shut off sampler

Noted Problems: ________________________________

Actions Taken to Correct Problems: ________________________________

Summary Comments: ________________________________

PRECIPITATION MONITORING CHECKLIST

Set-Up Crew Name: ____________________ Date & time that Set-Up is Completed: ____________________

Station Name: ____________________ Date & time that Shut-Down is Completed: ____________________

SET-UP CHECKS

______ Record rainfall from flow meter status screen

Total Rainfall (in): ______

______ Clear basket of any debris

______ Unwrap bucket insert using clean sampling techniques

______ Insert the insert into the holding bucket

______ Insert holding bucket into basket

SHUT-DOWN CHECKS:

______ Type of Precipitation

Rainfall ______
Snow ______
Mix ______

______ Carefully remove holding bucket with insert and sample from basket

______ Pour sample into 1-L poly sample containers

______ Put lid on sample bottle

______ Properly label full sample bottle, ID #: ________________________________

______ Record rainfall from flow meter status screen

Total Rainfall (in): ______

______ Complete Chain of Custody Form

Summary Comments:

SNOW MELT LOG SHEET

CHECKLIST TO BE COMPLETED AT EACH STATION

Set-Up Crew Names: ________________ Date & time that Set-Up is Completed: ________________

Station Name: ________________ Date & time that Shut-Down is Completed: ________________

Approximate depth of snow within drainage area

snow banks before: ____________ after: ____________

ground before: ____________ after: ____________

Weather conditions during week leading up to monitoring event

new snow amount ________________________________

temperatures ________________________________

Visual condition of snow pack in sampling area

freshly formed ________________________________

frozen ________________________________

melting ________________________________

discolored ________________________________

Recent snow management activities conducted by Caltrans

salting ________________________________

sanding ________________________________

plowing ________________________________

Runoff Appearance

source ________________________________

color/clarity ________________________________

other ________________________________

Additional comments